THE GLASS INDUSTRY

VOLUME 22, NUMBER 11, NOVEMBER, 1941

WATER HAMMER BREAKAGE IN GLASS CONTAINERS

PART II

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Hartford-Empire Company

Abstract of Part I.

Objective of research—to discover causes of 0.1 per cent field breakage in packed food jars.

Field breakage of an unusual type was eventually duplicated in the laboratory by dropping one packed carton onto another.

Moving pictures (1200 frames per second) showed that when the filled jar is subjected to a sudden vertical downward movement, the contents leave the bottom surface, move upwards relatively to the container, and then move downwards, striking the bottom and thereby possibly causing water hammer breakage. Investigations with a cathode ray oscillograph showed that this water hammer impact lasts about 1/10,000 second and that pressures as high as 250 lbs. per sq. in. on the bottom of the container can sometimes be developed before the bottle breaks.

The Intense Local or Pick Effect

Study of the general pressure effect mentioned previously showed that probably it was not the only cause of water-hammer breakage, since the pressures developed in the containers at the time of fracture were usually relatively low. Furthermore, while the fracture patterns in some cases were similar to pressure breaks, as would be expected, there were, however, too many fracture patterns that were definitely different. Some of these unusual patterns were discovered to have internal origins. Since these were found in new, previously unused, bottles, the internal origins could not have been caused by service scratches on the inner surface. Our continued investigations brought forth the rather startling fact that the water hammer itself developed tiny cracks, or checks on the lower inside surface of the bottle. It thus became apparent that there was another phenomenon, occurring practically simultaneously with the general pressure effect, which could produce intense stresses of a local character.

An explanation of these local stresses requires a certain amount of mathematical consideration. When a mass of liquid is suddenly pulled away from a solid surface, a void or cavity is formed. Usually at some later time this cavity collapses under the external atmospheric or the hydraulic pressure, and the liquid strikes the solid surface at a very high velocity, causing unusually high localized pressure.

A rough estimate of the pressures involved can be made from elementary considerations of the problem. Suppose

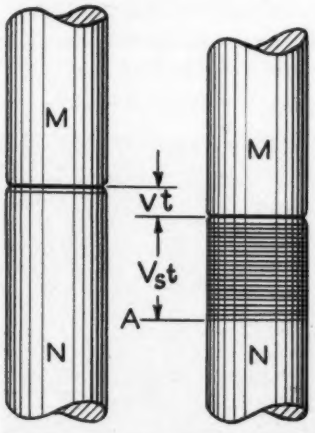


Fig. 14. Diagram of the impact between an incompressible bar M and a compressible bar N.

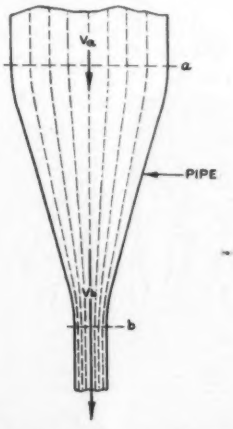


Fig. 15. Diagram of the increase of velocity when water flows through a constriction.

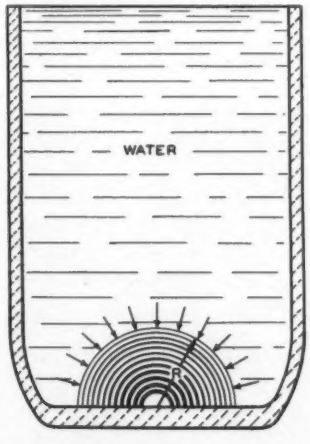


Fig. 16. Diagram of a collapsing bubble.

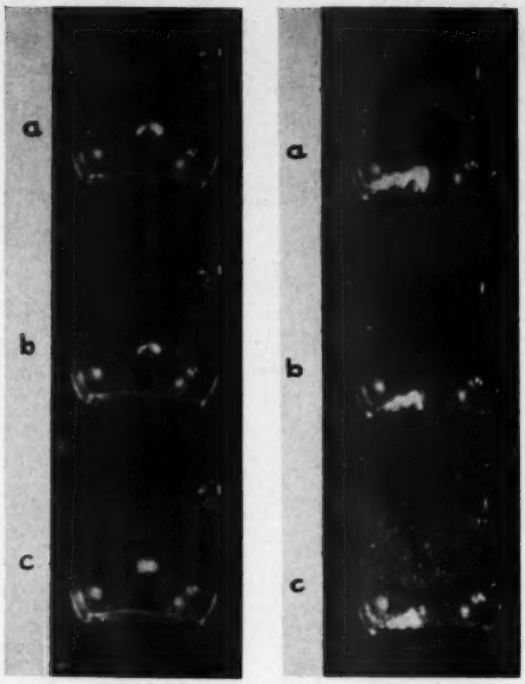


Fig. 17. Collapsing bubble. Successive stages at 1/1200 second intervals. Collapse took place between stages b and c.

Fig. 18. Cluster of bubbles collapsing against bottom of bottle. Successive stages at 1/1200 second intervals. Collapse took place between stages b and c.

a very stiff bar M, moving at a velocity v, strikes a relatively easily compressible bar N, as shown in Figure 14. In a very short time t afterward, before the bar M has lost an appreciable amount of its velocity, it will have moved a distance vt in the same time as the sound wave in bar N caused by the first part of the impact will have moved to A or a distance $V_s t$ where V_s is the velocity of sound in the bar N. Obviously, the contraction is vt, and the total length under stress is $V_s t$ and the strain S is given by $S = \frac{vt}{V_s t} = \frac{a}{V_s}$ and so the stress F becomes $F = Y\frac{V_s}{v}$, where Y is Young's modulus in the bar N.

The other phase of this localized effect is the tremendous

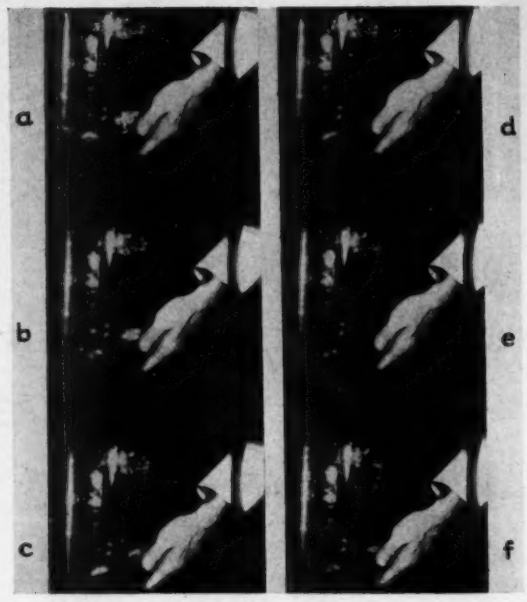


Fig. 19. Cluster of bubbles collapsing against sidewall of bottle. Successive stages at 1/1200 second intervals.

increase in velocity that can take place when a bubble collapses.

Now suppose we consider a column of water flowing through a constriction as in Figure 15. If the water flowing past a has a velocity V_a it must be flowing at b with a velocity V_b, such that $V_a A_a = V_b A_b$ or $V_b = \frac{V_a A_b}{A_b}$ or we may say that the velocity is inversely proportional to the area it is flowing through. Now in Figure 15, suppose the radius is 1 inch at point a, and the column of water passes there with a velocity of 10 ft. per second. Assume the diameter is 1/10 of an inch at b; then the velocity will be 100 times as great, or 1,000 ft. per second. Suppose at this point the water was suddenly stopped by interposing a piece of glass. If K is the modulus of compressibility of water, or about 300,000 lbs./sq.in., the pressure produced in the water would be given by $P = \frac{v}{V_s} K$, or 60,000 lbs./sq.in. If the radius dropped to 1/20 of an inch, the pressure would build up to 240,000 lbs./sq.in. on the surface. Although these calculations are very rough, the order of magnitude is clearly indicated.

Fig. 20. Cavitation erosion of brass when vibrated at 8700 ~ per second with an amplitude of vibration of .05 mm. under water.

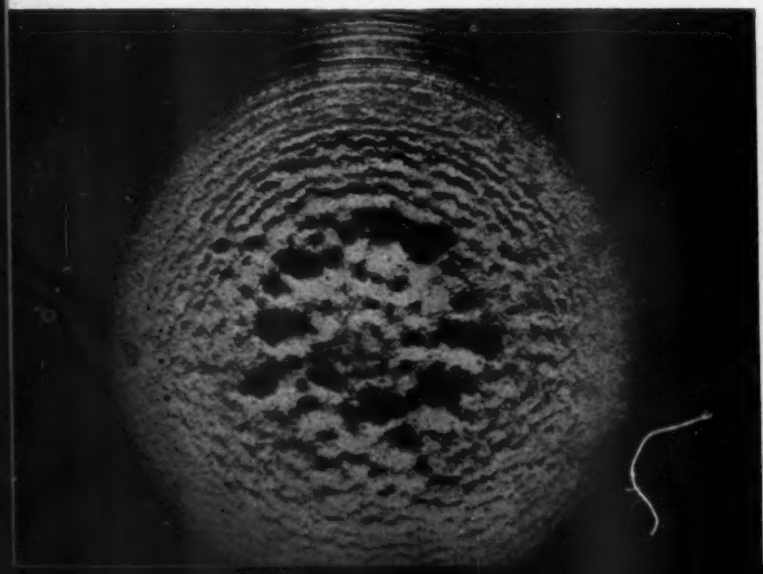


Fig. 21. Cavitation erosion of cold rolled steel.

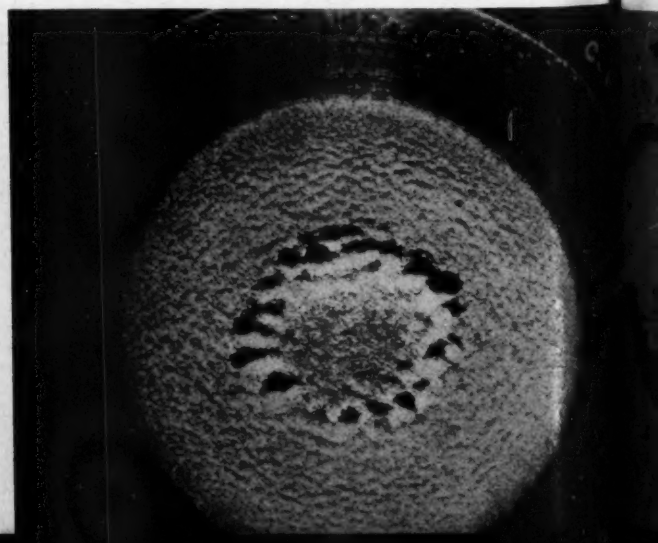


Fig. 22. Cavitation erosion on a glass specimen that had been vibrated for 23 minutes. (x 100).

Fig. 23. a. Single pick effect. (x 500).

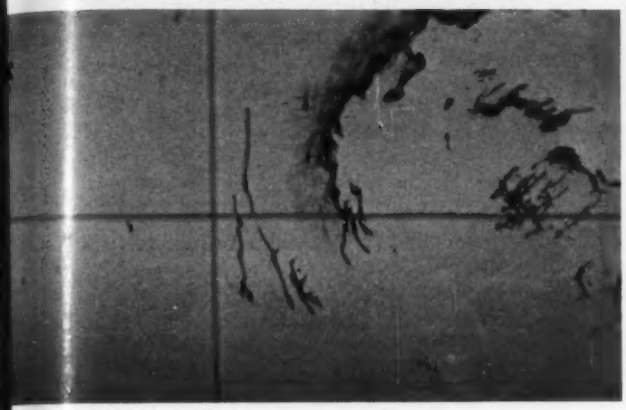
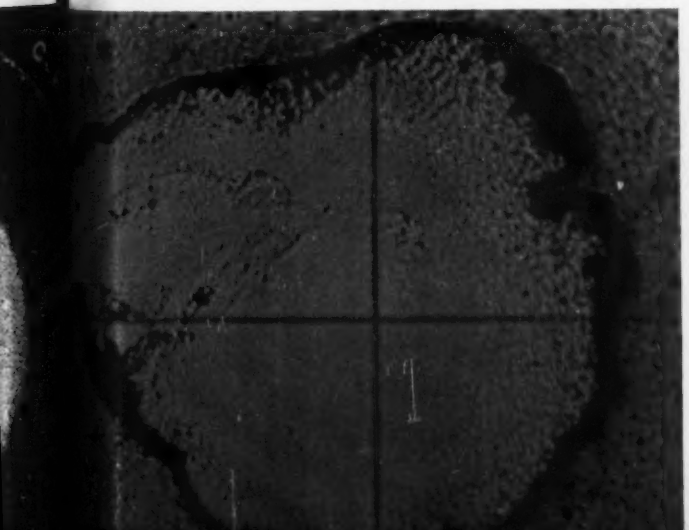


Fig. 23. b. Several intense picks. (x 50).

Fig. 23. c. Region around origin of fracture caused by repeated pick effect. (x 50).

Fig. 24. Circle cut out of shellac by pick effect. (x 100).



Now, if we have a hemispherical bubble collapsing, as shown in Figure 16, the area bounded by the liquid of this bubble is $2\pi R^2$. Therefore, if the water flows in from all sides, the area of the surface will decrease as the square of the radius and the velocity will increase inversely as the square of the radius.

Assume now that the velocity of the surface of the bubble is 10 ft. per second when the radius is ½ inch, then when the radius is 1/20 inch the velocity will be 1,000 ft. per second. Now we have noticed the checks made in glass are 1/1,000 to 5/100 inch in diameter, so it is obvious that pressures well over 100,000 lbs./sq.in. can be developed in these local areas.[3]

We have called this intense local effect the Pick Effect, in contrast to the more general pressures developed at the time of impact between the water and the bottom of the jar. The pick effect is necessarily much shorter in duration than the more general effect recorded by the cathode-ray oscillograph. It probably lasts only five to ten microseconds and could not possibly be detected on the oscillograph.

To slow down this phenomenon so that observations could be made more readily a large bottle was filled with water, allowing a suitable headspace, and water hammer developed by sharply snapping the bottle downward when held in the hands. The headspace was evacuated to substantially the vapor pressure of the water and this was probably the most important factor contributing to slowing down the action.

High-speed motion pictures (1,200 frames per second) were then taken of the bottle being snapped, from which it was estimated that the action itself was only about 1/60 as fast as when the headspace was at atmospheric pressure. When projected on the screen at normal speed, the action was further slowed down to about 1/4500 of the speed of the phenomenon with atmospheric headspace pressure, thus permitting detailed study. Consecutive frames at the time of collapse of bubbles are shown in Figure 17 in which a single bubble collapses in frames *a* and *b*. In frame *c* the bubble has collapsed and something resembling an explosion has occurred. This apparent explosion is probably caused by the very low pressure following the intensely high pressure of the sound wave. The low pressure opens up voids in the liquid which become bubbles as the small traces of air in the water come out of solution.

The bubble in Figure 17 is not collapsing spherically, so it does not become indefinitely small before impact occurs. In Figures 18 and 19 the collapse is seen to be due to the water rushing toward the central portion of a cluster of bubbles and the final impact takes place in a very com-

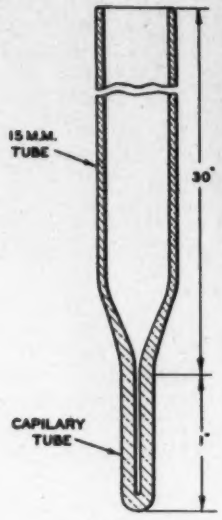


Fig. 25. Diagram of capillary tube joined onto a 15 mm. tube.

Fig. 26. Photograph of fractures of capillary tubes. Note the internal origins.

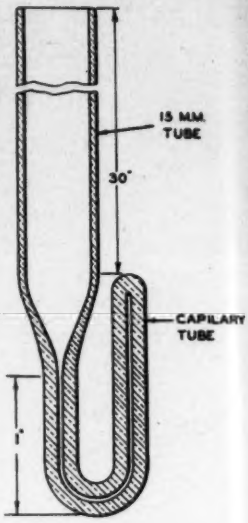


Fig. 27. Diagram of bent capillary tube.

plicated manner. The films separating the bubbles must prevent the collapsing system from becoming very small, thus keeping the velocities from becoming infinite.

It is to be noted in Figures 17, 18, and 19 that the water is travelling very fast in the frames immediately preceding collapse. In Figures 18*a* and *b*, we see that the water has travelled ½ inch in 1/1200 second, so that water must be travelling as much as 50 ft./sec. while the bubble is still nearly ½ inch across. On this basis the water might be travelling as fast as 5000 ft./sec. when the radius is 1/20 of an inch.

The phenomena just described occurred in a bottle with headspace vacuum corresponding to the vapor pressure of water at room temperature. We have found, however, that with commercial sealing vacua, clusters of bubbles collapse with sufficiently intense pressures to cause considerable damage.

In fields not related to glass this effect has been studied by several hydraulic laboratories, because it is known to be responsible for serious wear in hydraulic turbines and on marine propellers. Zones on marine propellers seem to be eroded by the repeated action of the pick effect which, in such extended form, is known as "cavitation erosion".

Messrs. Schumb, Peters and Milligan have written a paper entitled, "A New Method for Studying Cavitation Erosion on Metals".[4] In this paper they describe a method by which a vertical nickel tube is vibrated longitudinally at a frequency of about 9000 cycles per second. At the lower end of this tube the test specimen is rigidly attached, and is immersed one-quarter of an inch into the liquid. Figures 20 and 21 reproduced from their paper show cavitation erosion on brass and cold rolled steel. They found that even polished boron carbide was visibly roughened by approximately 20 minutes of their treatment.

Professor Schumb kindly tested a glass specimen for us. After being vibrated in water for 23 minutes the specimen developed a pit about 1/64th of an inch deep in the center, as shown in Figure 22. This experiment shows clearly that the impact of the water with the glass will actually break out tiny chips of glass where the bubbles are most prone to collapse.

This pick effect will take place wherever a bubble collapses. Of course, if a bubble collapses inside a liquid, nothing happens except that a sound wave is sent off which quickly attenuates, due to its spherical expansion. However, if the bubble collapses on the bottom or the sidewall of a jar, a tiny crack usually less than one-tenth of an inch long is often formed on the glass; frequently the crack tends to be circular, while occasionally concentric rings are formed. Usually it is necessary to etch the glass with hydrofluoric acid before these cracks become visible. Several photomicrographs in Figure 23 show various checks caused by this pick effect on the internal surfaces of bottles.

In order to see if such formation of checks on the glass could be prevented by a protective coating, the inside of a bottle was shellacked. When this internally coated jar was water-hammered a few times and examined, it was found that small circular rings were cut out of the shellac as shown in Figure 24. We also found that shellac did not appreciably prevent the internal damage to jars. The same experiment was tried with thin layers of soft wax and again circles were cut out. Finally, the bottoms of the jars were coated with sealing wax. In this case it was found that the sealing wax was broken away from the jar by the repeated action of the pick effect when water-hammered several times; as long as the wax was intact it protected the bottom of the jar. However, the sidewall of the jar just above the sealing wax was often severely checked, sometimes causing breakage at that point.

A somewhat different experiment gave a considerably greater insight into the pressures involved in the pick effect.

Fig. 28. Photomicrograph showing the extension of checks by the repeated pick effect. (x 25).

Fig. 29. Type I. Origin on external side wall with radial cracks forming spider web.

Fig. 30. Type II. Origin on external side wall making appreciable angle with axial direction of jar.

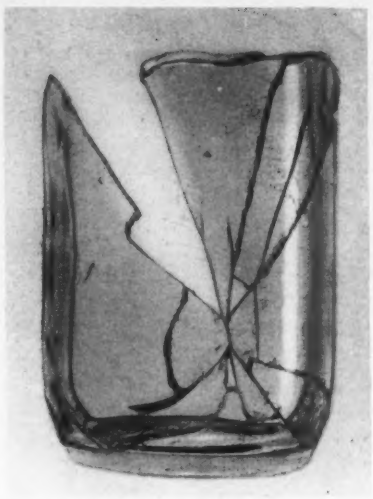


Fig. 31. Type III. Origin on external side wall approximately parallel to axial direction of jar.

A glass capillary tube one or two inches long was sealed to one end of a tube 15 m.m. internal diameter, as shown in Figure 25. Then the large tube was filled with water at the open end. When the air had been removed from the liquid and the capillary tube filled, the open end was pounded with a rubber hammer. After a few blows the capillary tube broke with an internal origin at its tip. Broken capillary tubes are shown in Figure 26. (Note the internal origins.)

In this system it seemed likely that the cavitation formed at the junction of the capillary tube and the large tube, and that a sound wave travelled the length of the capillary tube, breaking the tube at the point of reflection where the pressure would be doubled. To prove this point, a capillary tube was bent as shown in Figure 27. The capillary tube could still be broken at the tip. Since it is doubtful that cavitation formed at the tip, it must be assumed that the sound wave was responsible for the breakage. The sound wave does not rapidly attenuate with the square of the distance when it is in a capillary tube. The pressure must have been at least 20,000 to 50,000 pounds per square inch to cause breakage under these conditions.

We have seen that the pick effect can produce a check. If the pick effect strikes again in the same place, it will tend to open up the check. If it strikes several times in the same place, a crack $\frac{1}{8}$ inch deep can sometimes be made before the bottle breaks, as shown in Figure 28.

Internal checks made by the pick effect will greatly reduce the pressure strength of a bottle. A new, heavy, carbonated beverage bottle was water-hammered about fifty times, and then given a hydrostatic pressure test. It broke at 150, lbs./sq.in., with an internal origin. Normally these bottles stand at least 750 lbs./sq.in. as a minimum.

Tests with the oscillograph indicate that even a new, heavy walled soda bottle can be broken from repeated water hammer, when the general water hammer pressure never exceeds 65 lbs./sq.in. on the bottom, because the pick effect will extend the check to a point where the general pressure can knock out the bottom.

There is considerable additional experimental evidence to show that the pick effect takes place at the point of col-

Fig. 32. Type IV. External origin on baffle mark.

Fig. 33. Type V. External origin on base contact point.

Fig. 34. Type VI. External origin on central portion of base.

Fig. 35. Type VII. Origin on internal junction of base and side wall.

Fig. 36. Internal base rim origin.

lapse of the bubble caused by cavitation. If a bottle filled with a pure liquid is held at a slight angle with the vertical, it is often found that the pick effect produces checks at the lowest point in the bottle. When a bottle is filled with two immiscible liquids, such as oil and water, the cavitation bubbles are very apt to form at the interface of the two liquids. When such bottles are water-hammered, the pick effect may put checks on the internal side wall of the bottle at the interface level of the two liquids; sometimes the bottle can be broken with an internal origin at this point. When fine bubbles can be made to cling to the side of a jar, by trapping them in jelly, checks due to the pick effect can be made to form at these points.

Besides the damage done to the bottle internally, the pick effect can help to break the jar with an external origin. Of course, the pick effect is so highly localized that it has probably very little effect on the external surface of a thick walled container, but in the case of a lightweight container, where the side walls are 0.1 inch thick or even much less, one would naturally expect a considerable amount of local tension to be produced on the outer surface of the jar when the intense local pressure of the pick effect is developed. The pick effect will thus start the break on the outside of the side wall, causing immediate forking of the crack; however, the general pressure that follows up will not necessarily cause further forking, because the stress is often too low. When all the forking of the crack is near the origin, we may surmise the pick effect was chiefly to blame for the initiation of the fracture; when the forking continues a great distance from the origin, the general pressure has become great enough to produce the forking even though it was not enough to initiate the crack. Under favorable conditions it is possible to produce external side wall origins, when the general pressure, as shown by the oscillograph, is only a small fraction of the amount necessary to break the bottle. In the case of certain types of food containers, the pick effect breaks the bottle with an external origin with practically no help from the generalized pressure.

Water hammer in glass containers is thus seen to consist of two distinct phenomena:—one is a general pressure which is at a maximum at the bottom of the jar and tapers off to the top of the contents, and the other is an intense

(*Continued on page* 435)

Fig. 37. Internal base rim origin.

Fig. 38. Type VIII. Origin on internal side wall.

THE TOLEDO TRIAL RESUMES

A whirlwind windup by the Government to 15 weeks of testimony through which it expects to sustain sweeping charges of monopoly and price fixing in the glass container industry was marked in Toledo Federal Court last week by adverse rulings by Judge Frank L. Kloeb on two points which the Department of Justice attorneys admitted were important to their case.

First, the Government failed in the last of many attempts to have received in evidence the voluminous diaries of the late Herbert Knox Smith, former attorney and secretary of the Hartford-Empire Co. Judge Kloeb ruled on numerous occasions throughout the trial, which began last March, that the diary was of a personal nature and therefore not admissible.

Second, Judge Kloeb ruled against the introduction in any form of excerpts from the testimony given by witnesses before the Senate's Temporary National Economic Committee in 1938. The Government went to great length to get certain of these excerpts into the record. The last attempt involved an excursion of a large group of lawyers to Muncie, Ind., where a deposition was taken from Frank C. Ball, of the Ball Bros. Co. Mr. Ball, too ill to come to Toledo, denied that certain replies which he gave to questions at the TNEC hearings meant what the Government seeks to have them mean. The deposition was admitted in evidence except that the quotations from the TNEC record, the only part important to the Government, was ordered stricken.

The trial, in summer recess since last June, was resumed Oct. 14. The Government rested its case on Oct. 22, although rulings by Judge Kloeb on some of the 1,864 exhibits still have not been made. The question of professional privilege in some of the correspondence between attorney and client are involved in the rulings still pending. The Government and defense attorneys had prepared briefs on the question. These were being studied by Judge Kloeb.

Following completion of the Government's case some of the corporate defendants filed motions for dismissal on the grounds of insufficient evidence. The motions were accompanied by briefs. Those filing the motions were the Anchor Hocking Glass Co., the Glass Container Association, the Corning Glass Works, the Thatcher Manufacturing Co., and Lynch Corp.

The principal defendants, Hartford-Empire Co., Owens-Illinois Glass Co., Hazel-Atlas Glass Co., and Ball Brothers Co., indicated they would not press for dismissal prior to presentation of their sides of the case. These motions, and the briefs were to be considered by Judge Kloeb during the progress of the trial, decisions to be announced later.

Reopening of the case on Oct. 14 revealed that a separate controversy has arisen between the Hartford-Empire Co. and the Hazel-Atlas Co. over the validity of certain patents which are being used by the latter firm in its manufacturing processes. Attorneys for the two firms announced the dispute is to be arbitrated. Amos Conn, Toledo attorney, was the agreed upon arbiter. He will proceed with the hearing on the patent validity during the progress of the main trial. Thus there will be a virtual trial within a trial. The outcome of this controversy has a bearing on the anti-trust action since Judge Kloeb last June sustained a Government motion impounding the funds which the two firms pay to each other regularly under their patent licensing contract. The claim of validity for some of the Hazel-Atlas patents has resulted in a smaller sum of money being paid to the Clerk of Court under the impounding order.

Arthur T. Safford, Jr., secretary of the Hartford-Empire Co., was the final Government witness. He occupied the stand for five days, identifying scores of letters and documents which the Government took from the firm's files in 1938. The evidence thus introduced was largely of a corroborative nature, relating to the many inter-company relations in the glass industry, covered quite fully in the earlier Government testimony.

Particularly stressed was the story of the so-called "Lynch deal" of 1933, whereby the Lynch Corp., of Anderson, Ind., became the principal manufacturer of glass forming machines. Documents wherein the officials of Hartford-Empire discussed the advisability and legality of the proposed arrangement were among those introduced in evidence.

It was under this subject that another question, still pending before Judge Kloeb, arose. Hartford-Empire attorneys revealed that, contrary to the previous understanding, the Government had presented a subpoena to the firm in 1938 prior to the surrender by the officials of the files for Government inspection. The question thus presented is whether or not many of the documents constituting consultation by the firm's officials with their attorneys are admissible in evidence. The Government contends that the documents were surrendered voluntarily and that therefore privilege was waived.

Previously this had not been disputed by Hartford-Empire. However, while Mr. Safford was on the witness stand it developed that a copy of the Government's subpoena for documents had been found in the files. Whether or not this constitutes legal service of the subpoena is the question being weighed.

The trial to date has filled more than 6,400 pages of record, one of the longest in the history of the Toledo court.

Defense attorneys have taken courage from the decision of the District Judge in the famous anti-trust action against the Aluminum Company of America, in which the Government lost. However, they pointed out that nothing short of a Supreme Court decision can be interpreted as final in a case of such a nature.

The Hartford-Empire Co., first to present its defense, intends to take several weeks. Owens-Illinois will be the second to offer its proof. Attorneys agree there is little likelihood of the trial being completed before January.

Defense attorneys in the trial of the anti-trust action against glass container interests in Toledo were jubilant following the first day's testimony on their side of the case Oct. 27, due principally to a ruling by Judge Frank L. Kloeb admitting testimony of a nature which the Government felt certain would be barred.

Karl E. Peiler, recognized as one of the foremost engi-

(*Continued on page* 497)

WATER-GLASS: PART II

By DR. BRUNO SCHWEIG
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Editor's Note. **In reading this article, the reader should bear in mind that Dr. Schweig's first-hand information has been based entirely on European practice, which seems to be—contrary to popular impressions—less advanced than our own. His conclusions cannot be entirely reliable in so far as they refer to American silicates of soda, about which he evidently relies upon somewhat out-of-date reports. The chief interest in the paper must lie in the opportunity that it offers for comparing European and American practices. A word of caution, against accepting it as a picture of the most advanced procedures, may not be out of place.**

Use of Water-glass

The trade, as a rule, distinguishes between "water-glass," having the molecular ratio $Na_2O:SiO_2$ from 1, 2 up to 4 molecules SiO_2, and "meta-silicate," with a ratio 1:1 corresponding to the formula Na_2SiO_3 aq. Of these only $Na_2SiO_3.9H_2O$ is of technical importance. We have seen that meta-silicate is not genuine water-glass, as it can hardly be obtained in a glassy state, but very readily crystallizes. Still, meta-silicate can be and is made from water-glass and, vice versa, water-glass proper is manufactured from meta-silicate. Speaking, therefore, of the use of water-glass, we must include the meta-silicate. Their employment is the same.

From the point of view of industry, the soluble silicates are those of sodium and potassium, although all the alkali metals form silicates which dissolve in water, and even ammonia affects the solubility of silica. Because of their lower cost, the sodium compounds are used in amounts compared with which those of potassium silicates are insignificant. There are, however, a few cases where the distinctive advantages of potassium silicate gives them a place. Unless otherwise specified, sodium silicate will always be referred to.

The various applications of water-glass turn on its adhesiveness in the hydrated state, its vitrifying power in the dry state, its alkaline nature, its capability of yielding soluble silica, and its peculiar chemical properties as a whole.

A British manufacturer of silicate of soda recommends it in his advertisements for use in Laundry and Textile Industries, Paper Mills, Dairies, Metal Cleaning and Proprietary Articles. J. G. Vail, in his already mentioned book, "Soluble Silicates in Industry," devotes 250 pages out of 414 to their different uses. These indications alone suffice to give some idea of the manifold applications of water-glass.

A broad survey indicates that about one-fifth of the total production is used for the soap and cleaner industry, one-fifth for the textile industry, two-fifths for the paper mills, and the last fifth for all other purposes. In wartime, of course, the proportions of its use are altered, and a third, or even considerably more of the water-glass produced, goes into the soap industry.

Fireproofing, which normally absorbs only a minor part of the soluble silicates, becomes one of their most conspicuous applications in the present circumstances. Fireproofing is the method of making normally combustible materials fireproof by impregnating them with special solutions. The idea is to deposit minute crystals in the pores of the combustible materials, closing them with a non-inflammable substance, and thereby preventing access of air. Thus, while the fabric may char superficially by the exposure of its surface to a high temperature, it will not take fire.

One of the most suitable solutions for this purpose is water-glass. Several other substances can also be used, but hardly any with the exception of common limewash is so easily obtainable in wartime. It would not be surprising if the British Government made fireproofing with water-glass compulsory. Should that be the case, the consumption of water-glass for this purpose alone would soar. The protection now sought against the effect of fire-bombs would still be valuable in peace time.

Egg-preserving is one of the minor uses for water-glass, though perhaps, the most familiar. If done in the right way, silicate storage gives eggs which at the end of six months can hardly be distinguished from fresh ones.

The soap industry in times of war habitually has recourse to water-glass. So, with the probable intensification and prolonged duration of the war, a big increase in the use of water-glass can confidently be expected. It is, however, just as important to note that the employment of water-glass in the soap industry has also obtained a strong foothold in peace time. The amounts put into twenty brands of laundry soap sold on the American market in 1922 averaged about 12 per cent anhydrous silicate in the finished soap, and ranged from 1 to nearly 25 per cent. In other countries the conditions are similar, and in Germany, before the outbreak of the war, it was compulsory to add 20 per cent of water-glass to all soap manufactured. The water-glass not only replaces and saves fat, but in some respects also improves the quality of the soap.

As a detergent, sodium silicate is nearly always used, either alone or in compounds, wherever an inorganic cleaning material is required. Its power of deflocculation, wetting, emulsifying, and of increasing and stabilizing foam, as well as precipitating calcium and magnesium from hard water, and preserving bleaching compounds, etc., makes it an almost indispensable cheap all-

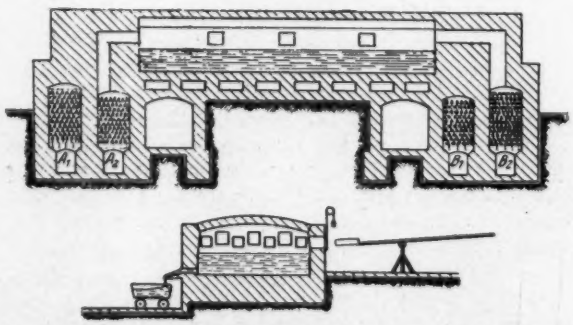


Fig. 4. Siemens-Martin tank furnace for water-glass. A_1, A_2, B_1, B_2 indicating the heat stores.

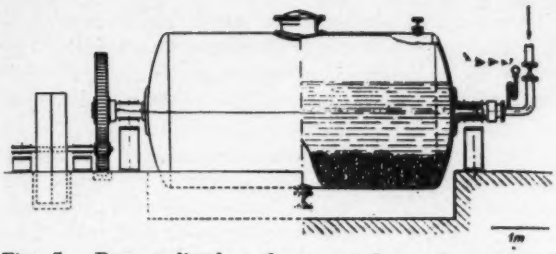


Fig. 5. Rotary dissolver for water-glass. Longitudinal section.

round cleaning agent. Several proprietary articles, such as "Metso," even indicate its presence by their name.

The adhesive properties of liquid water-glass are similar to those of many organic colloids. Water-glass has, moreover, several advantages. It is odorless, heat-proof, vermin-repellent, cannot rot, prevents the growing of fungus, and becomes eventually insoluble. It is again used pure or in mixtures with other materials such as starch, glue, casein, etc. It is especially employed as adhesive in the paper industry for cardboard and corrugated paper. Further, plywood and ceramic articles are often cemented with water-glass. Fig. 3 shows clearly how greatly the adhesive strength varies with the molecular ratio of Na_2O:SiO_2 and that it is all-important to keep the ratio as near as possible to three.

Cements of a good many kinds and for various purposes are made from water-glass. Fireproofing lutings for jointing firebricks, mixtures of water-glass and fibrous asbestos, water-glass in conjunction with clay, sand, or concrete are some of the applications. Its cementing properties are made use of in the manufacture of artificial stones: for instance, by the Ransome process of mixing sand with a solution of water-glass, and when dry soaking it in a bath of chloride of calcium, forming eventually an insoluble calcium silicate.

Variations of this process or similar ones are used for making vases, architectural ornaments, chimneys, abrasive wheels, spark plugs, etc. As a binder in the carbons used as electrodes in arc lamps, potassium silicate is preferred because of the color of the flames, which would be too yellow with sodium water-glass.

The textile industry makes extensive use of water-glass in different ways. It is employed especially: (1) for washing and bleaching, (2) for weighting, especially in the silk industry, (3) as a mordant and fixing agent for dyeing and printing, (4) for sizing and finishing, (5) for mercerizing, (6) for degumming silk, (7) for fireproofing fabric.

Interesting and important is the use of water-glass for silk weighting. Although recently advertisements have appeared in which the advantages of weighted silk are set forth, it seems dubious whether the weighting really means an improvement in quality, but it lowers the cost and strengthens the fiber. The fact remains that most silk is weighted, and that from 40 to 75 per cent with minerals, of which 40 per cent may be silica. Thus, for instance, the U.S. consumed in 1922 approximately 6,250 tons of water-glass for silk weighting.

Most of the other mentioned uses in the textile industry are self-explanatory. As a fixing agent, silicate solutions are effective for iron and chromium salts used as mordants, especially the arsenates and phosphates, which are rendered insoluble in a bath of one of the more silicious grades. In textile printing, silicates serve, for instance, where a viscous alkaline medium is required to apply a color or reagent in such conditions that the design shall remain clear and sharp. Mercerizing of cotton is found to be improved by substituting silicate of soda for caustic alkali.

Other purposes: Not all the manifold employments of water-glass can be described, but some require mentioning. Water-glass has created a special technique of fresco-painting, the so-called stero-chrome process. Furthermore, water-glass is used for pottery glaze, for making a porcelain mass (slip) more liquid with less water, for employment as manure, for water-softening, as a dressing for pruning-wounds; even in medicine as a therapeutic against tuberculosis, intestinal diseases and arteriosclerosis.

The short summary of the applications of the soluble silicates clearly shows their importance, which will increase not only during the war, but also in peace time. The more their properties are explored and science exhibits their limits and possibilities, the more will water-glass and its kindred silicates extend their service to commerce and industry.

The following paragraphs of this article will be devoted to the manufacture of water-glass.

The Manufacture of Water-glass

Introductory Notes: The manufacture of water-glass and all silicates of the type Na_2O, $nSiO_2$ turns, of course, on the problems of uniting the two constituents, sodium oxide and silicic acid—Na_2O and SiO_2—in the desired proportion, using the cheapest raw materials available and the method best suited for the purpose.

For Na_2O, the raw materials are obviously caustic soda, NaOH, or the sodium salts, carbonate, Na_2CO_3, sulfate Na_2SO_4, nitrate $NaNO_3$, sulfide Na_2S, and even common salt, NaCl, all of which can be converted to Na_2O.

SiO_2, silica, is available either as sand or as infusorial earth (Kieselguhr), flint, as amorphous silicic acid, obtained as by-product from other processes; also in compounds such as ferro-silicon and mangano-silicon; also in charred organic substances.

The combination of the materials of the two groups can be achieved by dry or wet processes. Considering the raw materials, familiar to the chemists and manufacturers for so many years, it is, perhaps, not very astonishing that fundamentally the same processes are in use as those which, about a century ago, the first industrial inventors, von Fuchs, Liebig, Kuhlmann, and even 300 years back, Glauber, suggested and used.

It seems to be a law of technical development that once an innovation or invention has reached a certain stage of perfection, it remains essentially in this quasi-classical state for a long time, often for centuries, before a change occurs. Sometimes it never does. This may be an encouragement for inventors whose good ideas are not easily superseded.

The Soda Ash and Salt Cake Process

Thus, the original dry process of producing water-glass, is still the most important one and the one used

almost exclusively on an industrial scale. About 75 parts of salt-cake (sodium sulfate), 8 parts coal, and 100 parts of powdered quartz sand or flint are fused at 1300°-1500° C. in a furnace for about 8-10 hrs.

When using soda ash (sodium carbonate) instead of the sulfate, about 55 parts of soda ash are mixed with 100 parts of sand. Sometimes some coal, about 2 parts, are added to facilitate the fusion. To further increase the fusibility of the alkali and silica a little borax is often employed in the mixture.

The fundamental reaction is assumed to be according to the equation:

$$2Na_2SO_4 + 2nSiO_2 + C = 2Na_2O.nSiO_2 + 2SO_2 + CO_2.$$

For carbonate water-glass the equation is:

$$Na_2CO_3 + nSiO_2 = Na_2O.nSiO_2 + CO_2.$$

It may be said that in the sulfate process as much as twice the amount of carbon stated in the formula can be used without yielding sulfides in the final product. It is, however, recommended to use a little less than the formal postulates. If too much is used, a dark amber-colored glass will result. A deficiency in carbon will leave Na_2SO_4 in the glass, an alternative which is usually accepted in practice.

Fusion of sodium or potassium carbonates with silica is perhaps the most important means of preparing alkali metal silicates. The raw materials are available in a high state of purity, they react at temperatures compatible with economical furnace operation, and the process lends itself to accurate technical control and yields neither offensive nor troublesome by-products.

For potassium carbonates, the above-mentioned carbonate equation, correspondingly altered, is valid. About 60 parts of potassium carbonate are required for 100 parts of sand and the quantity of coal generally added amounts up to 6 parts.

The Furnaces

The chief development since the early days of water-glass manufacture has taken place in the design of furnaces. They now operate much more economically and yield more uniform and better products at a lower cost on a then unattainable scale. As in the glass industry, the open-hearth regenerative type of furnace is most widely used, although satisfactory results are also obtained from reverberatory furnaces in which coal is burned on a grate, and from furnaces heated with mineral oil. Electric furnaces represent the latest development.

Tank furnaces are considered to be more economical than crucible. Fig. 4 shows a Siemens tank furnace in elevation and cross-section. They may be worked in shifts or continuously. Sulfate glasses, which attack the refractories of the furnace with much greater vigor than carbonate batches, are most successfully melted in continuous furnaces permitting a slow reaction.

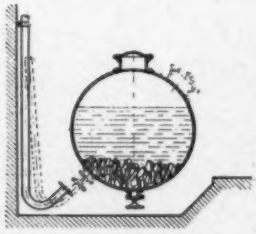


Fig. 6. Rotary dissolver. Cross section. Position for emptying in the dotted lines.

The silicate furnace differs from the glass furnace in that it is not essential for it to deliver an absolutely homogeneous product. Fine striations in the glass, representing slight variations in composition, seem to increase rather than retard the rate of solution.

Electric Furnaces: Water-glass can, of course, be melted in electric furnaces of either the arc or the conduction type. The question is one of the cost of the heat units supplied by electricity as compared with those supplied by coal or other fuel.

Plants of this kind are therefore erected where water-power provides electricity at a low price. At Niagara. the first electric plant was started at the end of 1932 and has been operating ever since. The produced sodium silicate is of the formula Na_2O, 3.265 SiO_2. Its purity is remarkable, the approximate analysis being:

	Per Cent
Na_2O	23.24
SiO_2	75.89
Fe_2O_3	0.043
Al_2O_3	0.195
CaO	0.069
MgO	0.069
TiO_2	0.01

The electric power consumption taken over all the period, including occasional stops, etc., for the care of equipment, can be taken as 700 kilowatt hours per ton of glass produced. For each 4½ square feet of furnace area, a ton of glass is obtained per day. Each furnace has an output of 30 tons of sodium silicate glass per 24 hours.

The initial difficulties in finding electrodes which do not dissolve and discolor the molten glass were overcome by substituting very pure iron electrodes for graphite ones which were originally used. The problem of refractories is still serious at the high temperatures employed.

Dissolving

Equally as important as the fusion of water-glass is the process of its solution in water, as water-glass is exclusively used in the liquid state. Some of its aspects are already dealt with under "Properties," and need not be repeated, but the fact that the dissolving operation has its intricacies make it a custom that, as a rule, the manufacturers of the solid water-glass also have taken over the task of dissolving it.

The methods of dissolving and the apparatus employed vary according to circumstances. Two outstanding principles are employed: "Alkaline" water-glass of the formula Na_2O, $2.06SiO_2$, and similarly-composed, relatively easily-dissolved brands are treated in stationary dissolvers. "Neutral" glass, Na_2O, $3.3SiO_2$, and those of kindred composition are dissolved in rotary digesters.

The stationary plants are vertical autoclave cylinders without provision for mechanical agitation. They are filled from the top, first with the pieces of solid water-glass, then with a diluted silicate solution supplemented by water; and eventually steam of 3 to 5 atmospheres (45-75 lb.) pressure is introduced. The circulation must be sufficient to prevent the heavy solutions which form at first from accumulating at the bottom of the vessel. After about three hours the process of dissolving is finished, the grade of the solution is tested and, if it is

found to be correct, the solution is expelled by the steam pressure into another vessel where some of the impurities settle. Then the solution is filtered.

The rotary dissolvers as shown in Figs. 5 and 6 are usually horizontal digesters of a length of about 15 ft. and a diameter of 6 ft., made of thick, riveted steel plate. In the middle is a hole, closed during the working, through which the dissolver is charged. Opposite is a tap with a nozzle for emptying. Through one of the bearings passes a tube by which the steam is introduced. By means of suitable gearing, the digester is slowly rotated at about 5 revolutions per minute. The charge is similar to that of the stationary apparatus, consisting of about a third of solid water-glass and two-thirds of diluted solution. With steam at about 3 atmospheres (45 lb.) and rotating, the dissolving takes some hours. Then the apparatus is stopped in such a way that the nozzle can be connected with an adjustable discharge pipe, and after letting off most of the steam, the water-glass solution is forced out into an empty container and treated as previously described.

The filtration is not always simple. J. G. Vail and J. Carter recommend, in their U. S. Patent No. 1,132,640 (1915) a slight content of aluminum as helpful, whereas magnesium has a retarding effect. A yellow color of the solution may have its cause in the presence of sulfides and organic impurities. Oxidizing bleaching agents such as hydrogen peroxide, chlorine water, or hypochlorite lye are employed. Sometimes the sulfides are precipitated with copper oxide.

Solutions of different molecular ratio are obtained by mixing solutions of higher and lower silica content. If the molar ratio has to be lower than 2 with sodium water-glass, or 3.6 with potassium silicate, caustic soda or caustic potash respectively are added.

For solutions of more than 40° Bé., evaporation of weaker solutions, either under normal pressure or in vacuo, is employed.

Wet Methods

A more serious competitor to the classical dry methods than the other mentioned processes of fusion, is the manufacture of water-glass by wet processes. The principles of most of them were laid down by the first investigators a great many years ago. The basic idea is to dissolve silicic acid in caustic soda or potash, as the case may be. Ordinary sand is hardly affected by alkali lye. It is, therefore, necessary to find suitable forms of silicic acid which are fairly easily soluble. Such sources for silicic acid are mainly:

(1) Infusorial earth (Kieselguhr)
(2) Flint.
(3) Precipitated silicic acid as by-product from other processes.
(4) Charred rice hulls.

When using infusorial earth, which is very convenient because of its great surface, one may proceed along the following lines. The earth is first calcined to free it from organic matter which would otherwise cause discoloration of the final water-glass solution. Then it is stirred in small quantities into boiling solutions of caustic alkali of specific gravity 1.22-1.24. It remains there for about three hours. Often an autoclave with a pressure of 3-4 atmospheres is employed. The partial clearing of the mixture indicates the end of the reaction. After dilution, the insoluble impurities are separated.

Flint must be ground before it is used. Then it is treated similarly to infusorial earth.

Precipitated silicic acid is a by-product of the manufacture of aluminum from clay, aluminum silicate. If this process were carried out on a large scale, an easily soluble silicic acid would then be at the disposal of water-glass manufacturers.

Rice hulls are sometimes used for making absorbent carbon. The hulls, which contain about 35 per cent silica, are first charred and then extracted with sodium hydroxide solution.

Another method called the Jaubert or Silicol process, designed to produce hydrogen, yields silica of soda as a by-product according to the following equation:

$$Si + 2NaOH + H_2O = Na_2O,SiO_2 + 2H_2$$

Though silicon itself would be the most suitable material for this process, for reasons of economy alloys such as ferro-silicon and mangano-silicon are used. During the last war, the British Admiralty erected a plant for this process, but as this method is rather uneconomical, it is hardly a peace-time proposition.

Electrolysis may just be mentioned, not as a method of manufacturing ordinary water-glass, but as a means of preparing silicates with especially high molecular ration such as Na_2O, $4.2SiO_2$ which are difficult to produce by other methods.

Other Dry Methods

Whereas the fusion of carbonate and sulfate of soda, or potassium, with sand by the help of carbon is the industrial process employed almost exclusively, other dry methods have been suggested and tried out. Sodium nitrate and sodium hydroxide could be substituted for the usual salts though without advantage. The manufacture of water-glass by the direct fusion of common salt, NaCl, with sand would be very valuable if it could be carried out economically. The existing method for this process is as follows: The chlorine of the sodium chloride is transformed into hydrochloric acid by the addition of steam to the molten salt according to the equation:

$$2NaCl + H_2O + nSiO_2 = Na_2O,nSiO_2 + 2HCl$$

It is, however, very difficult to distribute the steam evenly throughout the mass, and, in addition, the chlorides are very volatile. If this process were successful and could replace the sulfate process, 360 kg. sulfuric acid, now lost as SO_2, could be saved per ton of solid water-glass.

In conclusion, it may be said that at present none of the wet processes outclasses the classical dry methods. but that the future or special circumstances may bring unexpected developments.

This survey of water-glass is written with a special view of the importance of water-glass in wartime. The scope of the soluble silicates has, however, already reached such dimensions in peace time and is obviously still extending so that some manufacturers of ordinary glass may think it well worth while considering whether the change-over to water-glass production might not be opportune.

WAR STIMULATES PRODUCTION OF AMERICAN MADE GLASS NOVELTIES

Like the Demuth Glass Works' plant and operations which were described in the September issue of THE GLASS INDUSTRY, the factory which converts glass rod into finished glass objects is far removed from the mass production plant turning out containers, plate or window glass. The converter of glass rod is engaged in producing novelty pieces of glass for the different trades. The glass used is bought in tube or rod form in small quantities often in a myriad number of colors and is melted in small gas fired "fire boxes" and not in the pot furnaces or tanks that one sees in the conventional glass factory. These small shops are usually located in the various cities that are the centers for the novelty and jewelry trades. Production is by hand and semi-automatic machines and the output is governed by the immediate demand for the article. The total glass tonnage used is not great, but then, a great many small objects can be made from a ton of glass.

One of the largest of these novelty companies in the New York area is the Marimac Novelty Company. They not only manufacture glass parts, but parts of synthetic porcelain, cast-stone and treated coral for table decorations. The factory was established in 1921 in New York City by Max Greenan who was formerly in the artificial flower business for the millinery trade. When the millinery trade business slackened, he started making the flowers and petals of glass. In 1923 the business expanded enough so that he needed extra room and moved the shop to Rosebank, Staten Island. Under one roof are now centered the different divisions of the factory that make center pieces, flower holders, cigarette holders, etc., out of glass, cast-stone, synthetic porcelain, plastics and coral. The company is a family affair. Max Greenan is the owner. His wife is the designer of the novelty pieces made in the factory. Lew Greenan, a brother, is production manager of the factory, and a sister is manager of the New York office.

Glass, in rod form, is bought mostly from the Demuth Glass Works, Brooklyn, N. Y. It is melted in small, clay lined, fire boxes, heated by cross-fires. City gas is used at line pressure and is mixed with 3 pounds of air. The rod is fed by gravity down a chute into the fire box where it melts on the bottom of the box. The molten

A typical set up of fire box and semi-automatic machine.

Pressing out buttons on one of the machines.

A gather is wound around a form to make a flower holder.

Glass balls are made on the end of a short pipe.

Max Greenan, the owner, watches a worker assemble a center piece.

Final inspection and then packing for shipment.

glass is gathered on the end of a steel rod and is fed into the side arm, semi-automatic press. These presses punch out the amount of glass needed, form the button or bead, punch the hole or holes, and drop the completed piece down a chute to an annealing pot. These unique presses, designed and built in the company's shop, are of the horizontal, side arm, three motion, type. The operator sits at a bench with the fire box ahead of him and gathers the glass with his right hand. His left hand operates the press. On small leaves (about an inch in diameter and 3/32's of an inch thick) the operator can turn out two to four leaves a gather. On an 8 hour day, he can turn out 30 to 35 gross. The pieces are annealed in closed, gas heated, iron pots at a temperature of about 800 to 900° F. for a period of 2 hours and then removed.

For leaves, petals, etc., that have stems, the cane is put up in bundles (about 8 rods per bundle) and wired in several places to hold it together. It is put through the side of a fire box where a flame plays on the end of it and melts the glass. Any number of different colored rods may be put into the bundle to get any desired color or blend of colors. Short pieces of brass wire about 6 inches in length are placed at one side of the fire box for the operator to use for gathering the glass on one end. The gather is shaped in a small hinged press and then transferred to an arbor press which presses out the leaf or petal. The piece is then put into the annealing furnace. Ten to twelve gross can be made daily. Flower forms and cigarette holders are made by gathering on the end of the brass wire, pulling the gather out and winding around a brass pipe form.

One of the assembly benches.

Tomatoes, oranges, grapes and plain balls of glass are made by gathering a gob of glass on the end of a short ½ inch piece of iron pipe and blown into shape. Bases up to 3 inches in diameter and candle holders are made by gathering a gob of glass on the end of a piece of steel rod and then shearing the glass into a mold in an arbor press and pressed into shape. The larger bases and special shapes are supplied by one of the glass companies from private molds.

There are nine men working in the glass shop under the direction of James Hall who acts as foreman and general machinist. The men work 8 hours a day and five days a week. These men use on the average of 1½ to 2 tons of glass rod per week making the glass parts used in the assembly of the novelties.

From the glass shop the completed glass parts are taken to the assembly room. Girls working at long tables assemble the different parts, wind the stems with wire or tape, and fit them into the bases. The stems are twisted and bent into the final shape. They are then wrapped in tissue and boxes for shipment. An inventory of the different kinds of materials used in the different sizes and shapes of the novelties runs well over 600 items. Some of the materials are as follows: glass, wire, paper, cloth, gums, rosins, plastics, lacquers, hearts of flowers (60 types), screws, nuts and bolts, 68 kinds and sizes of wire (from 036 to .80), 60 sizes of cartons, aniline and pigment dyes, shellacs and varnishes to produce certain colors and 28 types of lacquers.

The war has decidedly affected the American glass novelty business, and the changes are mostly for the betterment of the industry. Aside from the shutting off of imports, novelty designs originating in this country and that were sent abroad to be marketed were fresuently copied and sent back to the United States to be sold at a great reduction in price. Not only have these imports been cut off, but the export trade to new foreign markets in Central and South America, Mexico, Cuba and Africa has been considerably expanded.

INVENTIONS AND INVENTORS

A Summary of Patents of Interest to the Glass Industry Issued During September

Compositions

A zinc borate glass for optical lenses, developed by an American Optical Co. group is described in patent 2,254,633. The inventors are Edgar D. Tillyer and Harold R. Moulton of Southbridge, and Townsend M. Gunn of Attleboro, Mass. Zinc oxide and boron oxide would comprise at least 80 per cent of the glass, with small amounts of other oxides, including in all cases compounds of beryllium or aluminum to stabilize the glass against weathering and corrosion. Characteristics of such glasses are said to be their high index of refraction, high reciprocal relative dispersion and low fusing point. Actual temperature data for fusion are not detailed in the patent.

Low expansion glasses of simple composition are covered by patent 2,255,558, assigned by Robert H. Dalton of Corning, N. Y., to the Corning Glass Works. The composition range was stated as 91 to 95 per cent SiO_2, 4 to 8 per cent Al_2O_3 and 0.4 to 2.0 per cent B_2O_3. Students of phase equilibrium data will recognize in these compositions only a slight modification of Bowen and Grieg's lowest melting composition (eutectic) for the system SiO_2—Al_2O_3. In fact one of the patent claims may be viewed as the SiO_2—Al_2O_3 eutectic with an addition of 1 per cent B_2O_3. An unexpected property of these glasses is their low thermal expansion coefficient which is reported to be below that of fused silica. As would be expected, their softening points are also lower.

Hellmuth Fischer of Ilmenau, Germany, received patent 2,255,109, for his discoveries in connection with luminescent glass of the type in which uranium or lead provide the luminescent properties. The principal disclosures were that luminescence was increased by adding 3.5 per cent ZnO, and by choosing the alkalies so that the K_2O would exceed Na_2O by at least 2.1. Fischer shows the step by step changes resulting from these and other additions.

Luminescent compositions for coatings and similar applications were described in patent 2,255,761 granted to Ezio T. Casellini of Salem, Mass. (Hygrade Sylvania Corp.), and in three patents assigned to General Electric Co. by foreign inventors. These patents were 2,254,956 and 2,257,667 granted to Gunther Aschermann, Berlin-Charlottenburg, Germany, and 2,257,699 granted to Alfred H. McKeag and Peter W. Ranby of North Wembley, England.

An ink suitable for applying a trademark to the inside of a lamp bulb is described in patent 2,254,865 which issued to John C. Wilson of East Orange, N. J. (Westinghouse Electric & Mfg. Co.). A preferred percentage composition is 20.9 per cent lamp black, 4.2 per cent TiO_2, 1.2 per cent silver oxide, and 73.7 per cent glycerine.

Furnaces

In the operation of a regenerative glass tank wherein the air for combustion is passed through checker work to preheat it, variation in atmospheric conditions influences the quality of the preheated air. Toward minimizing these differences John L. Drake of Toledo, in patent 2,257,229, assigned to Libbey-Owens-Ford Glass Co., has devised a regenerative system in which the air is preheated before passing through the checker work. This is accomplished in a narrow heating chamber arranged alongside of each checker-chamber and receiving its heat by conduction through the walls. This apparatus is shown in Figure 1 which is a plan view of a reversible regenerative furnace, with the right-hand heating system shown in section. When the furnace is being fired from the right, air enters the narrow outer passages as indicated by the arrows at the lower right. It is heated as it passes lengthwise of the narrow chambers and is drawn through air intakes at 28, where the course of flow is reversed so that the heated air will be carried through the checker-work and into the furnace. It will be recognized that the conventional system does not have the narrow side chambers and that untreated atmospheric air would be drawn directly to the checkers from the intake at 28.

Feeding, Forming, and Shaping

Cellular or foamed glass block is the subject of research in more than one organization, as shown this month by patents issuing to Corning Glass and Pittsburgh Plate Glass inventors. The group of patents for this type of product held by the latter company was already extensive. The newest Corning patents, issued to Sanford L. Willis of White Plains, N. Y., are three in number (2,255,236 to, 238) but may be considered as one since they stem from a single patent application which was divided in the patent office. The invention is

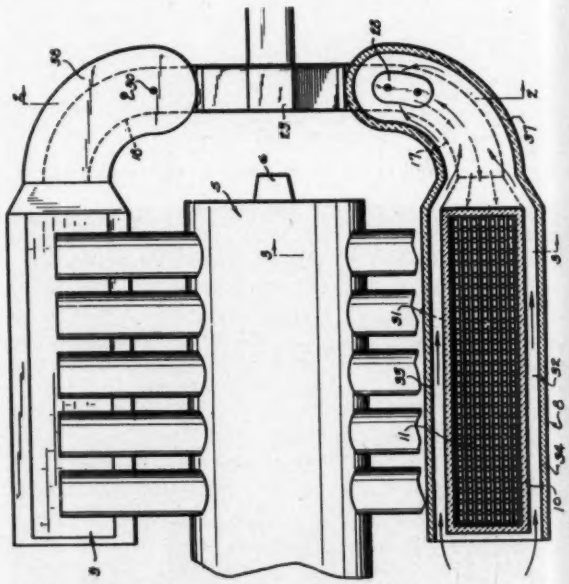


Fig. 1. 2,257,229: Drake. Regenerative system in which the intake air first passes through narrow passages alongside the checker-chambers.

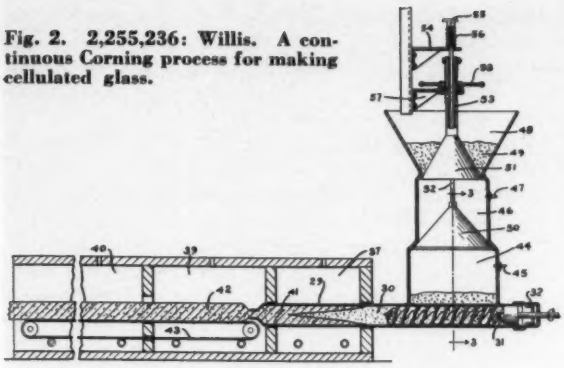


Fig. 2. 2,255,236: Willis. A continuous Corning process for making cellulated glass.

that of a continuous process of making a foamed glass blank or column in which the steps of foaming, shaping the blank, annealing it, and cutting it into unit sizes are each parts of a continuous operation. As shown by Figure 2, pulverized glass is charged through an air-lock 46 at the right to screw conveyors 31; compressed air admitted at 45, permeates the glass particles as they enter the "sintering tube" 29, and causes the glass to foam or bloat as the body of material is passed through that portion of the sintering tube which is within the furnace 37. The heat is sufficient to sinter and coalesce the glass particles and to entrap air in the voids, thus forming a fritted mass containing countless bubbles of compressed air. The frit is then forced continuously through a shaping orifice into a second heating chamber at a higher temperature, where the frit becomes less viscous and the compressed air expands to increase the cellularity. The conveyor 43 carries the product into an annealing lehr 40, and then to a position where it may be cut into blocks or sheets by grinding or sawing. In an alternative process the expansion of the frit in chamber 39 would be confined by walls which would control the size and provide a slicked vitreous surface.

The latest Pittsburgh Plate Glass Co. patent on cellular glass is 2,257,681, issued to Elmer H. Haux of Tarentum, Pa. Although Haux has previously disclosed continuous patented forming processes for making this product, this latest invention is confined to a unit method in which foaming is accomplished in single molds rather than in a continuous column or sheet. The invention is illustrated for application to the method in which powdered glass is mixed with calcium carbonate which decomposes above the sintering temperature of the glass with gas evolution within a mold. Haux now provides a tunnel kiln through which the molds are moved on such a schedule as to give them the necessary heating, cooling and annealing. One difficulty is the tendency of the upper surface of the blocks to form a crust which cracks open during the expanding step. This is overcome by the provision of a suitable top plate which rides on the glass.

In Figure 3, Haux provides for filling the molds at 25, moving them to the right through the bloating section of the tunnel kiln to a platform 15 at which the top and side plates are stripped from the molds. The cellular blocks are then moved to the lower level of the kiln, which is the annealing section and are moved leftward through it. The annealed blocks are then ready for sawing or other final dressing steps.

Edward G. Bridges of Anderson, Ind. (Lynch Glass Co.) has patented some far reaching modifications of his earlier rotary gob-fed bottle machine described in patent 2,069,130. The new patent is 2,254,992. In conventional operation of this type of machine the parison forming cycle consists only in the steps of blowing the charge downward into the neck to compact it, then counter blowing it upward to form a parison of predetermined length, and then transferring it to a finishing mold where a certain dwell permits it to reheat before blowing to finished form. In the modified process the counter blown parison is not transferred immediately to a finishing mold, but is given a second counter blowing to cool it additionally, and is then inverted to neck end up position with the blank mold opened. The latter step is spoken of as an idle period whose purpose is to allow the chilled skin to reheat prior to final blowing. In this position elongation of the parison is prevented by a paddle which strikes its bottom surface.

Miscellaneous Processes

The art of tempering glass is still so new that a satisfactory technique has not been worked out for articles of all shapes and sizes. A particularly difficult problem, the treatment of lantern globes and insulators for high voltage conductors, is dealt with in patent 2,254,227 issued to Evan J. Lewis of Corning, N. Y. (Corning Glass Works). One phase of the invention may be discussed in reference to Figure 4. This represents a heated electric insulator in position for chilling by air blast to temper it. It is desired to give the head of such insulators a greater temper than the skirt portion. Consequently the cooling head from which air is directed at the ware is divided into two portion 43 and 43a. The entire product may first be chilled by air from both 43 and 43a, and then in a second stage of the process, air would be shut off from 43 so that only the head of the insulator is cooled additionally. During this period some annealing would take place within the skirt. This illustrates only one application of the principles disclosed in Lewis' patent.

A machine for buffing small bottles such as perfume containers to remove mold roughness was patented by August J. Weiss of Baltimore (2,254,671, Maryland Glass Corp.).

Apparatus for vacuum sealing containers is described in patent 2,254,642, assigned to Owens-Illinois Glass Co. by H. A. Barnby, Wm. B. Hullhorst, and C. P. Whittier of Toledo.

Patent 2,254,853 to I. E. Mouromtseff, Montclair, and

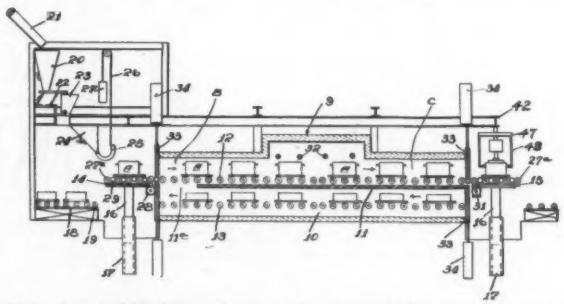


Fig. 3. 2,257,681: Haux. A process for continuously moving molds within which cellulated glass is produced by gas evolution.

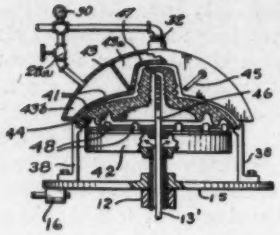


Fig. 4. 2,254,227: Lewis. Cooling head which gives a variable temper to glass insulators.

George M. Dinnick, Bloomfield, N. J. (Westinghouse Electric & Mfg. Co.) concerns a glass to copper seal for electric discharge devices.

Plate and Sheet Glass

Details of the conveyor system in a plate glass inspection device are described is patent 2,257,230 assigned to Libbey-Owens-Ford Glass Co. by John L. Drake.

One of the early Polaroid patents, 2,168,220, granted Aug. 1, 1939 to Edwin H. Land of Boston (Polaroid Corp.), has been reissued as Re. No. 21,904.

Patent 2,254,541 concerns a sheet glass trimming device patented by Elmer E. Nordgren of Hastings, Minn.

Glass Wool and Fiber

Patent 2,255,578 issued to Clyde A. Baker, Corning, N. Y. (assigned to Owens-Corning Fiberglas Corp.) is presented as an improvement in the well known fiber forming process whereby the fibers are drawn from tiny apertures in refractory metal bushings. Such bushings form the bottom portions of electric remelting furnaces. As shown in Figure 5, Baker constructs the furnace from insulating firebrick and lines it with a thin sheet (0.004 in.) of platinum alloy which however is of greater thickness at the drawing apertures; he then impresses an electric potential on the metal walls and working section in parallel, to obtain heat for melting the glass. Due to the greater mass of metal at the apertures the tendency for the glass to cool excessively at this point is overcome.

Means of winding glass fibers on a drum or spool are shown in patent 2,255,426 issued to Armand Lamesch, Aachen, Germany, and assigned to Schlesische Spiegelglas-Manufactur Carl Tielsch G.m.b.H., Waldenburg-Altwasser, Germany. The method consists in so jacketing the spool that the glass filaments are wound onto it within a layer of air concentric to the spool. The threads are more naturally directed to the spool.

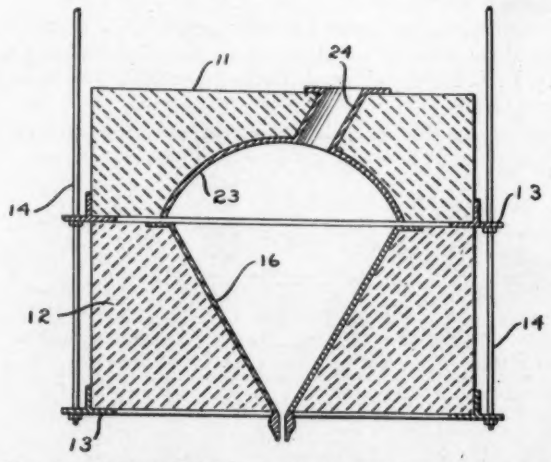


Fig. 5. 2,255,578: Baker. Bushing design for melting furnace which is aimed at preventing chilling of glass fibers drawn from it.

Owens-Corning Fiberglas Corp. received by assignment from Alfred L. Forster of Glasgow, Scotland patent 2,257,112 which covers a method of shaping concave coverings for pipe insulation. The glass filaments drawn by blast from the metallic bushing which forms them, are blown by this blast into a perforated mold having a shape conforming with the object to be insulated. A perforated section advances progressively across the mold so the wool will be built up progressively into a loose insulating mass of the desired shape.

Mineral wool patents were issued to Joseph R. Parsons, Chicago (U. S. Gypsum Co.) and to Wm. E. Carson of Riverton, Va. The Parsons patent, 2,255,227 provides for blowing the wool horizontally, and intersecting the path of blow with a cross current to deflect the fibers and allow the particles of glass shot to be removed as they strike a baffle. The Carson patent, 2,256,665 is concerned with recovery of the lightest fibers which do not fall in the collecting chamber but are normally lost into the air.

CHEMICAL DURABILITY OF GLASS

An interferometer method for determining the chemical durability of glass to a series of glasses over a wide range of conditions of time, temperature, and pH have been applied by Donald Hubbard and Edgar H. Hamilton. The results, which were given in the August *Journal of Research*, National Bureau of Standards, emphasize the fact that there can be no single test by which the durability of glass can be judged with respect to all conditions of service. The method has been particularly helpful in accounting for many of the anomalies of the glass electrode.

RESEARCH LABORATORIES SUPPLIES

The Division of Priorities of the OPM has formulated a plan known as the "Research Laboratories Supplies Plan" to provide preference ratings for material necessary for the continued conduct of scientific research. The OPM has entered into an arrangement with the National Academy of Sciences, under which the Division of Priorities will have the benefit of the advice of the Academy with respect to all applications which it may receive. If the Division of Priorities approves the application, it will issue to the laboratory the order applied for.

Any research laboratory which is unable to obtain the materials necessary for its continued conduct of scientific research without the assistance of the Plan, may apply to the Director of Priorities for Preference Rating Order No. P-43, assigning a preference rating of A-2 to deliveries of material which will be used for scientific research conducted by the laboratory. Application should be made on Form PD-88, and should specify the Preference Rating Order applied for and, under Paragraph 2 of the application, the branch of scientific research in which the laboratory is engaged. The completed application should be forwarded to the Chemical Branch, OPM, Washington, D. C., which will refer it to the Division of Priorities.

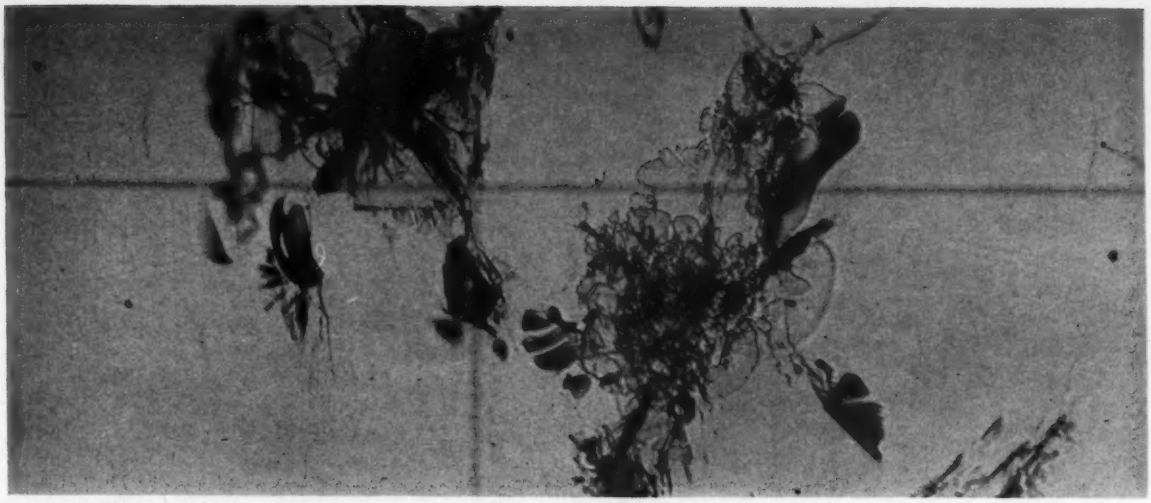


Fig. 39. Photomicrograph showing the repeated pick effect starting an internal base center origin leading to Type IX breakage. (x 50).

WATER HAMMER BREAKAGE

(*Continued from page* 474)

local effect which takes place in the lower regions of the jar. The problem of water hammer breakage resolves itself into the study of the factors which influence the relative amount of damage caused by these two phenomena.

Types of Water Hammer Breaks

In the case of ordinary pressure tests, the bottle breaks at its weakest point. In the case of water hammer, there is merely a tendency to break at the weakest point. If some zone of the bottle tends to be weak, we may expect a considerable amount of breakage there; but the usual case in containers is that the strengths of the various lower regions of the bottle are fairly comparable and do not differ in pressure strength by more than a factor of ten or so. In such cases water hammer breakage is considerably complicated by the fact that pick effect can easily compensate for the differences in strength and initiate an origin at the point where it strikes, before the general pressure effect is able to start a fracture at some weaker place in the glass. Since several factors can change the position and intensity of the pick effect relative to the general pressure of origin due to water hammer.

A list of the various types of water hammer breakage has been compiled with a few comments on the conditions necessary for their formation, and the likelihood of their occurrence in laboratory and field breakage. We will limit ourselves here to the study of cylindrical jars, as they are the most frequently used. The fracture patterns in rectangular jars become too varied to cover in a short paper.

Type I—Origin on the External Side Wall with Radial Cracks Forming a Spider Web

Figure 29. The rather small origin is on the external side wall with cracks radiating in all directions, somewhat resembling a spider web. It would appear that this type of break is caused primarily by the pick effect, and that only slight modifications are made by the generalized pressure. The peculiar conditions necessary for the production of this type of break are, (1) a check on the outer sidewall, with (2) the pick action localized directly behind it on the interior surface of the container wall. Other contributing conditions that are almost ideal for this type of breakage are (3) a headspace vacuum of 20 inches of mercury or more, (4) a food which has settled and protected the bottom of the jar for a half inch to an inch, (5) fine bubbles adhering to the side wall right above the thickened part of the food, and (6) checks in the outer surface within this same zone. The occurrence of this combination of conditions seems to be the rule for cases of water hammer breakage complaints in tomato catsup, soup and strained food containers. The result is that about 70 out of 100 breaks occurring in the field show this type of fracture. In laboratory tests this fracture is very difficult to produce unless the conditions previously mentioned are met. Shaking the foods will prevent this type of fracture and produce other types. Pure liquids practically never produce this type of fracture.

Type II—Origin on the External Side Wall and Making an Appreciable Angle with the Axial Direction of the Jar

Figure 30. The main conditions for this type of origin are about the same as in the case of the Type I break. It would appear that the general pressure effect continues the fracture and the subsequent forking. The intensity of the pick effect is less in comparison with the general pressure effect. This break can be produced with a pure liquid when the outer side wall is rather badly damaged. About 15 of every 100 field breaks so far studied are of this type.

Type III—Origin on the External Side Wall and Approximately Parallel to the Axial Direction of the Jar

Figure 31. This type resembles closely a hydrostatic pressure break; in fact, sometimes the two fracture patterns are indistinguishable. The general pressure effect is chiefly responsible, and usually considerable shattering of the jar takes place. The conditions necessary for a Type III break are (1) a check on the outer sidewall and (2) a homogeneous liquid on the inside of the jar. (3) High headspace pressures, atmospheric or even slightly greater, are helpful to the formation of this

type of break. Only one or two in a hundred field breaks are of this type, and there is considerable question as to whether or not they may really be Type II breaks, except that the pick effect has started the origin axially. When the Type III break is produced in the laboratory, considerably more forking and shattering of the glass takes place. Laboratory tests made with a pure liquid and atmospheric pressure in the headspace, yield this type of break with annoying frequency.

Type IV—External Origin on the Baffle Mark of the Base

Figure 32. The condition necessary for the production of this break is (1) a checked baffle mark. (2) The use of a pure liquid such as water accentuates this type of break, and (3) high headspace pressures are also helpful. The pick effect probably helps considerably to cause this fractures when it strikes directly above the baffle mark. However, the general pressure effect can no doubt break the bottle with no help from the pick effect. Foods whose solid particles have settled to the bottom tend to inhibit this type of breakage. In a specific instance of jars which uniformly exhibited checked baffle marks, and which had a little over 0.1 per cent field breakage, there were only five baffle breaks per hundred. When tested in our machines with pure water about 80 per cent of the breaks were baffle breaks.

Type V—External Origin on the Base Contact Point

Figure 33. The necessary condition for this type of fracture is a heat check 1/64 of an inch or more deep and ⅛ of an inch long made in the manufacturing process. If the pick action takes place immediately above the check and the bottom of the jar is thin, the jar will easily be broken. However, it appears that the general pressure effect usually causes this type of break, producing a fracture very similar to the hydrostatic pressure break with the same origin.

In a certain type of jar with base contact checks about ten out of every hundred field breaks had origins in this zone. When tests were made in the laboratory on the same type of ware with water as the contents, about 50 per cent of the breaks were of this type. Foods which had settled out on the bottom considerably reduced this type of breakage in our later laboratory tests.

Type VI—External Origin on the Central Portion of the Base

Figure 34. The necessary condition for this type of fracture is a check in the central portion of the base—a poor valve mark is usually the cause. The general pressure effect is the more probable cause for this type of fracture, although the pick effect taking place on the inner side of the base may easily be a contributing factor. About one break in a hundred field breaks shows this type of fracture.

Type VII—Origin on the Internal Junction of the Base and Side Wall

Figure 35. The necessary condition for the production of this type of fracture is that the pick action be allowed to strike at the junction of the base and side wall, thus making a severe check in this region on the inside of the jar. Figures 36 and 37 depict clearly the internal origins of such fractures. The general pressure sometimes opens up the check, causing complete fracture. A pure liquid favors the production of this type of break. Foods which have settled out on the bottom of the jar tremendously inhibit it. Repeated light water hammers make this type of break nearly a certainty.

Only one or two in a hundred field breaks show this type of fracture. On the other hand, when new bottles without any glaring defects are tested filled with water, this break tends to appear 90 per cent of the time. In laboratory tests a ⅛ inch layer of sealing wax was used on the bottom of the test jars to prevent this break while other phases of the jar's strength were being studied.

Type VIII—Origin on the Internal Side Wall

Figure 38. The initial check was made by the pick effect and the general pressure effect extended the crack. The conditions favorable to this sort of breakage are a strong outer sidewall and strong base of the bottle, and a layer of water under a layer of oil so that cavitation can start where the interface touches the sidewall of the jar. We have seen no field breaks of this type and have produced it in the laboratory only with some difficulty on a salad dressing jar.

Type IX—Internal Origins on the Central Portion of the Base

The conditions favorable to this type of break are a viscous liquid of about 50 poises. The pick effect slowly pounds a check into the mid-central zone of the bottom after several impacts. This fracture has only been produced in the laboratory, and then only occasionally. Figure 39 shows a photomicrograph of the crack starting in the middle of the base.

[3]For a more comprehensive treatise on collapse of a spherical cavity refer to Lord Rayleigh's "On the Pressure Developed in a Liquid During the Collapse of a Spherical Cavity," London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, Ser. 6, v. 34, VIII, 94-98 (1917).

[4]Messrs. Schumb, Peters, and Milligan, "A New Method for Studying Cavitation Erosion on Metals," Metals and Ailoys, 5, v. 8, 126-132 (1937).

(The concluding installment, Part III, will appear in the December issue.)

GLASSWARE MATERIAL SURVEY

The American Glassware Association, New York City, has sent to all members of the glass industry making ware other than containers, bottles, and flat glass a "Material Usage for Glass Manufacture Report." The consumer goods industry may be one industry which will have to justify its requirements for raw materials since only a small portion of glass manufactured by this branch of the glass industry can be considered as prime defense material.

This report, when filled out, will be merged with the other company reports to form a complete picture of the needs of this branch of the glass industry to operate. Also, the Association will be in a position to produce factual data from which it can present the industry's case to the government officials, if and when the information is required.

• Net profits of $6,996,560.48, or $2.78 per share for the nine months ended September 30, as compared with profits of $7,314,781.78, or $2.91 per share, for the same period in 1940.

CURRENT STATISTICAL POSITION OF GLASS

During September the glass industry continued to operate at the record level set in August; employment and payrolls held to their previous peaks with increases reported in some quarters. According to THE GLASS INDUSTRY's Production Index, output during September totaled $41,000,000, bringing the January-September cumulative total up to $338,000,000 as compared to $264,000,000 in 1940's corresponding period.

Plate glass production during September totaled 14,905,517 square feet according to the Plate Glass Manufacturers of America. This was 6 per cent greater than the previous month's total and the volume reported for September 1940. During the first 9 months of 1941 plate glass output amounted to 150,047,208 square feet as compared to 113,750,803 square feet in last year's comparable months—an increase of 32 per cent.

Window glass production during September totaled 1,123,159 boxes which was 12 per cent less than the August total but exceeded September 1940 by an equal percentage. Cumulative figures for the January-September period indicate an output of 12,033,000 boxes or a gain of 25 per cent over last year. During September the window glass industry operated at 69.2 per cent of capacity.

Glass container production during September totaled 6,286,294 gross, according to the Glass Container Association of America. This was 7 per cent less than the August total but exceeded September 1940 by 47 per cent. During the first 9 months of this year, production totaled 51,117,520 gross as compared to 40,845,000 gross in last year's corresponding period. These figures indicate that productive activity in this branch of the glass industry has been 24 per cent greater than last year.

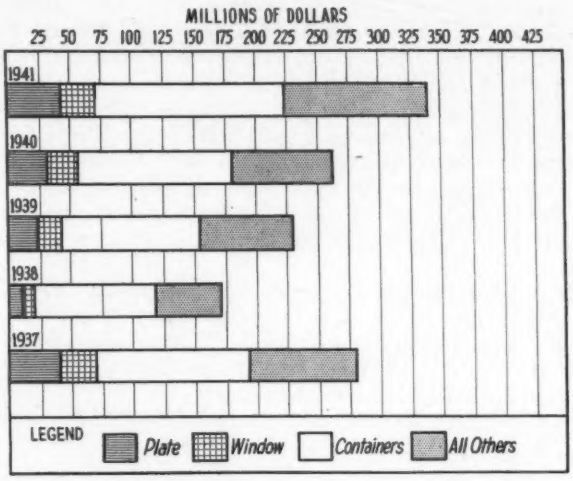
Shipments of glass containers during September increased 1 per cent over the previous month's total to 6,902,210 gross. This was 51 per cent greater than the September 1940 total. Outstanding gains were reported over last year's corresponding month for beer bottles, domestic fruit jars and pressure and non-pressure ware, all of which doubled in volume. Sales of domestic jelly glasses increased 90 per cent and milk bottles volume rose 65 per cent; other increases ranged from 23 to 45 per cent. Cumulative figures for the January-September period indicate that this year's shipments have exceeded 1940's volume by 31 per cent, having established the record total of 52,462,859 gross. An analysis of the trends in individual lines reveals that sales of domestic fruit jars have doubled, and all other types have made substantial gains—domestic jelly glasses 42 per cent, beer bottles 38 per cent, general purpose ware 37 per cent, liquor ware, milk bottles and pressure and non-pressure ware 34 per cent, food containers 28 per cent, and medicinal and toilet ware 25 per cent.

Inventories of glass containers continued to decline during September so that by the end of the month they had dropped 21 per cent below last year's level. Stocks of all types of ware were lower, with decreases ranging from 2 to 43 per cent.

Miscellaneous glass products manufactured during September were valued at $15,000,000—an increase of 40 per cent over September 1940. During the first three-

THE GLASS INDUSTRY'S INDEX

Production: Nine Months, January Through September



CURRENT GLASS CONTAINER STATISTICS

(ALL FIGURES ARE IN GROSS)

Types of Ware	Production		Shipments		End of Month Stocks	
	Sept., 1941	Sept., 1940	Sept., 1941	Sept., 1940	Sept., 1940	Sept., 1941
Food Containers (Narrow neck, wide mouth, and pressed)	1,899,321	1,419,202	2,263,685	1,727,080	1,740,080	2,179,593
Pressure and Non-Pressure Wear	355,717	194,823	333,162	144,481	454,534	614,027
Beer Bottles	358,503	129,826	396,331	90,514	503,522	566,737
Liquor Ware	1,111,781	721,076	1,071,375	727,673	1,366,397	1,479,075
Medicine and Toilet Ware	1,769,645	1,270,404	1,897,526	1,283,599	2,377,291	3,129,881
General Purpose	336,354	305,411	410,083	311,655	392,273	578,392
Milk Bottles	330,124	210,600	341,516	207,452	291,831	326,058
Fruits and Jellies	100,696	18,197	157,765	49,886	158,041	384,824
All Other	24,153	17,794	30,767	19,759	36,398	33,702
Total, Industry	6,286,294	4,287,513	6,902,210	4,562,099	7,321,175	9,292,289

quarters of this year this output totaled $139,000,000 as compared to $105,000,000 last year.

Machine-made tumbler production during September amounted to 4,407,434 dozens which was 28 per cent greater than 1940's corresponding month. During the first 9 months of this year tumbler output totaled 39,165,362 dozens—17 per cent above last year's level. Shipments during September increased 50 per cent over September 1940 to 4,997,781 dozens, increasing the January-September total 21 per cent above 1940's comparable period to 39,580,186 dozens. Stocks on hand September 30, 1941 amounted to 7,207,577 dozens which was 7 per cent less than last year's corresponding figures.

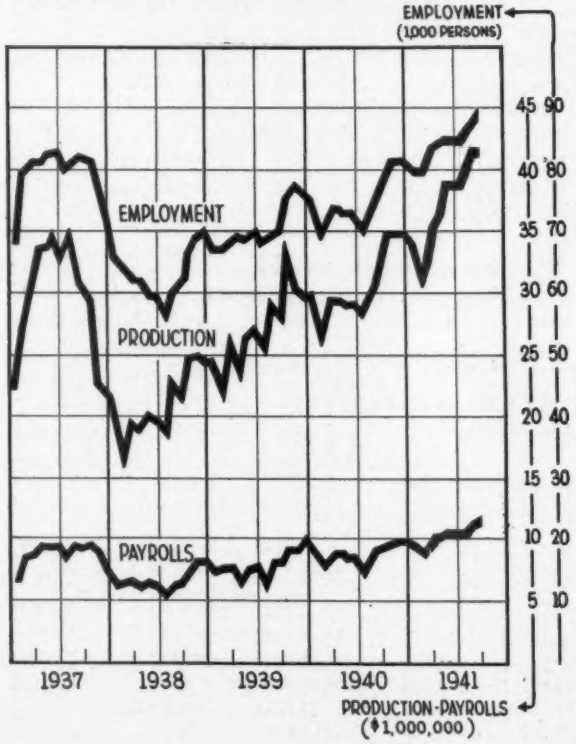
Manufacturers' sales of machine-made table, kitchen and household glassware totaled 3,427,241 dozens or 30 per cent more than a year ago. For the 12 month period ending September 30, 1941 this trade amounted to 38,397,347 dozens which was 15 per cent greater than in the previous comparable months.

Employment and Payrolls: Approximately 90,000 persons were employed in the glass industry during September as compared to 88,000 in August. This represented an increase of 18 per cent over last year's corresponding total of 76,000 persons.

Payrolls in the glass industry during September were estimated at $11,800,000—a gain of $300,000 over the previous month and $3,000,000 more than last year's corresponding figure. During the first 9 months of this year, glass manufacturers paid out almost $96,000,000 in wages; last year's comparable total was $75,000,000.

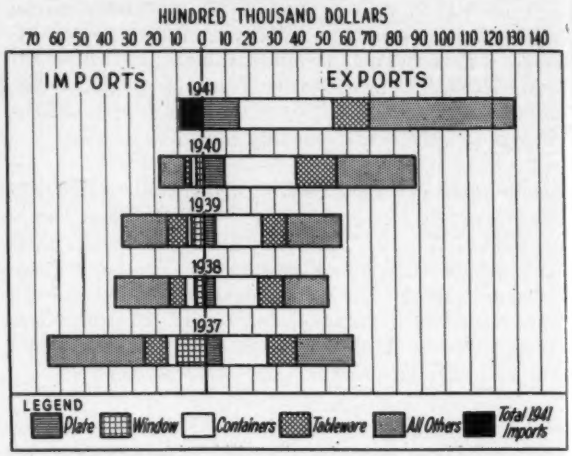
GI THE GLASS INDUSTRY'S INDEX

Monthly Trends Through September, 1941



GI THE GLASS INDUSTRY'S INDEX

Foreign Trade: Eight Months, January Through August



Foreign Trade: Exports of glass and glass products during August amounted to $1,799,000 according to official figures released October 14th by the Department of Commerce. This was 51 per cent greater than the July total and exceeded August of last year by 45 per cent. Increases over the previous month were reported for all types of ware with gains running from a 7 per cent increase in illuminating ware to a 76 per cent jump in tableware exports. Comparison of these August figures with 1940's corresponding month reveals that there was expansion in foreign sales of all glass products with the exception of illuminating ware which registered a decline of 13 per cent; tableware was up 8 per cent, plate glass 57 per cent, containers 14 per cent and window glass exports were about four times greater. During the first 8 months of this year exports totaled $13,004,000 as compared to $8,879,000 in 1904's comparable months.

Imports of glass and glass products during August were 17 per cent higher than in July, recording a volume of $110,000; this was 38 per cent below the August 1940 level. During the January-August period imports totaled $882,000 or less than half of last year's corresponding total of $1,806,000.

FOREIGN TRADE STATISTICS

(VALUES IN $1,000)

Exports	*August* 1941	*July* 1941	*August* 1940
Plate	151	110	96
Window	208	144	56
Containers	508	352	443
Tableware	303	172	168
Illuminating ware	55	51	63
All other	574	359	419
Total	1,799	1,188	1,245
Imports			
Total	110	94	175

• Charles F. Lumm has been named to the technical staff of Battelle Memorial Institute, Columbus, Ohio, where he has been assigned to the division of ceramic research. Mr. Lumm is a chemical engineer.

NEW EQUIPMENT AND SUPPLIES

FURNACE INSPECTION DOOR

A furnace inspection door, designed to withstand high temperatures, has been developed by the Gillette Kiln Sales Co., Pittsburgh, Pa. The door is applicable to various types of industrial furnaces, heat treating furnaces and on boilers and kilns having continuous temperatures up to 2500° F. The door is of rugged construction and consists of a cast-iron slide which rides vertically in a cast-iron frame assembly, and has no moving parts to warp or stick. When closed, the slide rests against the bottom of the frame with its upper section, ribbed to dissipate heat, closing the opening in the brickwork. To open, the slide is raised to bring a framed, rectangular piece of Pyrex heat resisting glass opposite the port hole. When an instrument or tool is to be inserted into the furnace, the slide has only to be raised completely above the brickwork port.

The inspection door is easily installed on new or existing furnaces. The anchor bolts span three courses of standard firebrick, and are easily inserted, while the opening has the width of a standard firebrick.

MOTORIZED ROLL GRAB

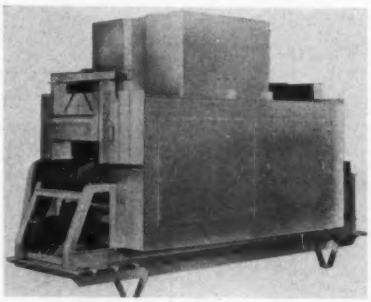
A new, completely motorized roll grab has been developed by the Cleveland Tramrail Division of the Cleveland Crane & Engineering Co., Wickliffe, Ohio, for use with its overhead materials handling systems. The grab will handle rolls from 16 inches minimum to 60 inch maximum diameter in lengths up to 72 inches and weighs up to 5000 pounds.

All motions of the grab are motorized and can be controlled from the crane operator's cab. Three motors are provided. One motor spreads and retracts the grab arms. Another squeezes the roll grippers after they have been brought close to the roll, and thus securely locks the roll in position and prevents any possibility of slipping away and falling in transit. The third motor operates the turn-over mechanism which makes it possible to pick up a roll in any position and place it in any other position. Thus a roll piled vertically can be picked up and placed in a horizontal position. The grab, or variations of it, is suitable for handling bales, barrels or boxes.

HIGH-POWERED COMMUNICATOR

A new "Executone" executive station of advanced design provides high-power for contacting selectively up to 20 substations or paging all such stations simultaneously, has been announced by the Executone Corporation, New York City. With this new model, it is claimed natural two-way conversations are instantly possible. Substations can be private or remote. Super-powered and directional trumpet-type substations are available for noisy locations or long range sound coverage. Several executive stations can be connected with each other for complete intercommunication between important department heads. Each such station can be connected to up to 20 other stations in the system.

The station stands 10 inches high, 12 inches wide, and 9 inches deep, housed in an acoustically designed hand-rubbed walnut finished cabinet with harmonizing Bakelite knobs, and push buttons. When less than 20 stations are used, additional equipment can be added to the system at any time without disturbing the original installation.



COVECTION HEATED FURNACE

A new conveyor type convection heated low temperature heat treating furnace has been developed by the Gehnrich Corp., Long Island City, N. Y., for heating operations up to 1250° F. The furnace has an all alloy steel interior, eliminating the need for refractory linings. The furnace walls are made of patented, insulated Dual Panels packed with mineral wool blankets. This construction eliminates through metal joints and consequent heat losses and provides for ready expansion and contraction of the walls, easy assembly, enlargement and reallocation, if the need arises.

The heat source consists of electrical heating elements. A fan located above the oven draws the heat from the heaters and discharges it over the full length and width of the oven. The heated air returns to the heater and through the fan, completing the recirculating system. The furnace can be arranged for heating by means of a gas or oil fired external air heater. The conveyor consists of a wire mesh belt which runs over steel drums at both ends of the oven and is driven by a motorized variable speed drive.

This type of furnace or oven is applicable for drying or baking of bulk chemicals, annealing and stress relieving of metal castings and ceramic and glass products. For this purpose, preheating and cooling sections can be easily added to the heat processing chamber.

pH PAPER DISPENSER

A new and more convenient method of using the Hydrion pH test papers throughout the range pH 1 to 14 is provided by a plastic dispenser just announced by R. P. Cargille, New York City. The dispenser holds and seals two 15-foot rolls of Hydrion pH test paper. When using the dispenser there is no container to open and close—the user merely pulls out and tears off the test paper needed. Color charts are visible through the transparent walls of the dispenser.

CATALOGS RECEIVED

Morgan Construction Co., Worcester, Mass. A bulletin on the Isley System of "Push-Pull" Ejectors for regenative furnace combustion control.

The Brown Instrument Co., Philadelphia, Pa. A catalog, "Thermometer and Pressure Gauge Accessories," No. 6706-A. This catalog is presented as a supplement, listing and describing bulbs, sockets, tubing and accessory items for the complete line of thermometers and pressure gauges.

Harbison-Walker Refractories Co., Pittsburgh, Pa. A folder describing "Korundal" brand high-alumina brick. These brick are designed for service under conditions of soaking heat and exposure to severe action at high temperatures. The standard sizes for Korundal are the same as those for fireclay brick.

Fairbanks, Morse & Co., Chicago, Ill. A new revised edition of "Catechism of Electrical Machinery," The "Catechism" explains electricity and magnetism as utilized in electric motors and generators, and important electrical measurements. The book is illustrated with photographs and diagrams. Tables of practical application are included.

Seamlex Company, Inc., Long Island City, N. Y. Two new bulletins, No. 300 and No. 410. No. 300 illustrates the standard types of Seamlex flexible seamless all-metal hose with patented-triple seal couplings suitable for temperatures up to 300 deg. F. No. 410 lists standard sizes, safe working pressures, factors of safety, etc.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	....	....
Precipitated material		55.00	60.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00–16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated, In bags,	lb.	.0215	.027 –.0295
Powdered, In bags,	lb.	.024	.0295–.032
Boric acid (H_3BO_3) granulated, In bags,	lb.	.048	.054 –.0565
Calcium phosphate ($Ca_3(PC_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.950–.975	.10
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00–13.25	
40 mesh	ton	11.50–13.75	
Granular	ton	11.75–14.00	
Semi-granular	ton	11.00–13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags.			
Fluorspar (CaF_2) domestic, ground, 96–98% (max. SiC_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	32.00	....
In bags	ton	33.60	45.00–48.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.0835	....
In 5 Ton lots	lb.	....	.0875
Less than 5 Tons	lb.	....	.0925
Lime—			
Hydrated ($Ca(OH)_2$–MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO–MgO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$–$MgCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$–$MgCO_3$) 16x20 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.50	16.00
Potassium carbonate—			
Calcined (K_2CO_3) 96–98%	lb.	.065	.0675
Hydrated 80–85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4) in bags	ton	18.00–20.00	25.00
in bulk		16.50	
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In Paper bags	Per 100 lb.	1.10	....
In Burlap bags	Per 100 lb.	1.15	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	3.00–3.40
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.4675	1.48
100 lb. bags		1.475	1.50

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.031–.034	.045
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.15	.15½–16
Arsenic trioxide (As_2O_3) (dense white) 99%		....	.04–.04¼
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	10.00	13.00
Sodium fluosilicate (Na_2SiF_6)	lb.	....	....
Tin Oxide (SnO_2) in bbls.	lb.	....	.55
Titanium Oxide (ceramic grade)			
In bags	lb.	.14½	.14¾–.15¼
In barrels	lb.	.14¾	.15 –.15½
Zinc Oxide (ZnO)			
American process, bags	lb.	.07	.07¼
White Seal, 150 lb. bbls.	lb.	.09	.09¼
Green Seal bags	lb.	.08¼	.08½
Domestic White Seal bags	lb.	.08¾	.09
Red Seal, bags	lb.	.07¾	.08
Zircon			
Refined Granular (Milled .01–.02c. higher)		.06½	.07–.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40–1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.10–1.15
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.25–.28
Chromite (99% through 200 mesh)	ton	55.00	58.50
Chromite ore (air floated)	ton	55.00	58.50–73.00
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.20–.22
Black (CuO)	lb.	....	.19–.22½
Black prepared	lb.	....	Open price
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.06–.10
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035–.05
Lead Chromate($PbCrO_4$) in bbls.	lb.	....	.16
Lithium Carbonate	lb.	....	1.25
Manganese, Black Oxide (Caucasian)			
In Paper bags	ton	70.00	78.00
In Burlap bags	ton	71.75	79.75
In Casks	ton	74.00	82.00
Neodymium oxalate, 50 lb. drums	lb.	....	4.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35–.40
Nickel monoxide (NiO), green	lb.	....	.35–.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.09½	.09¾–.10
Powdered	lb.	....	.10¼–.10½
Potassium Chromate (K_2CrO_4) 100 lb. kegs.	lb.	....	.27
Powder blue	lb.	....	.21–.25
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07¼	.07½–.07¾
Sodium chromate (Na_2CrO_7) Anhydrous	lb.	.08⅝	.08⅞–.09⅛
Sodium selenite (Na_2SeO_3)	lb.	....	1.50–1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.65
Yellow	lb.	....	1.65
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.40	3.75–4.15
Flowers, in bags	Per 100 lb.	3.05	3.40–3.80
Flour, heavy, in 250 lb. bags	Per 100 lb.	2.95	3.30–3.70
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.55
Yellow orange	lb.	....	1.65

Polishing Materials

		Carlots	Less Varlots
Emery, Turkish	lb.	.105	.08
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	open price
0, 0½, ½, 1	lb.	....	open price
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	.02¼	.03½
Rouge, Red	lb.	.18	.16
Black	lb.	.15	.18

Detail of decorated glass brick wall. By the noted artist Joep Nicolas, internationally famous for his glass painting. Now exhibiting at Orrefors Galleries.

● Whether it be for a beautifully decorated wall, or an ordinary tumbler, glass that is being manufactured today must meet high standards of beauty and durability. And the leading glassmakers of today have found that Mathieson Dense Soda Ash is a distinct aid in meeting and maintaining these same high standards. The uniform, granular composition of Mathieson Dense Soda Ash means quick, efficient melting. It is free from large particles, dust or foreign matter that might affect the quality of the finished glass. Let us quote on your dense soda ash requirements.

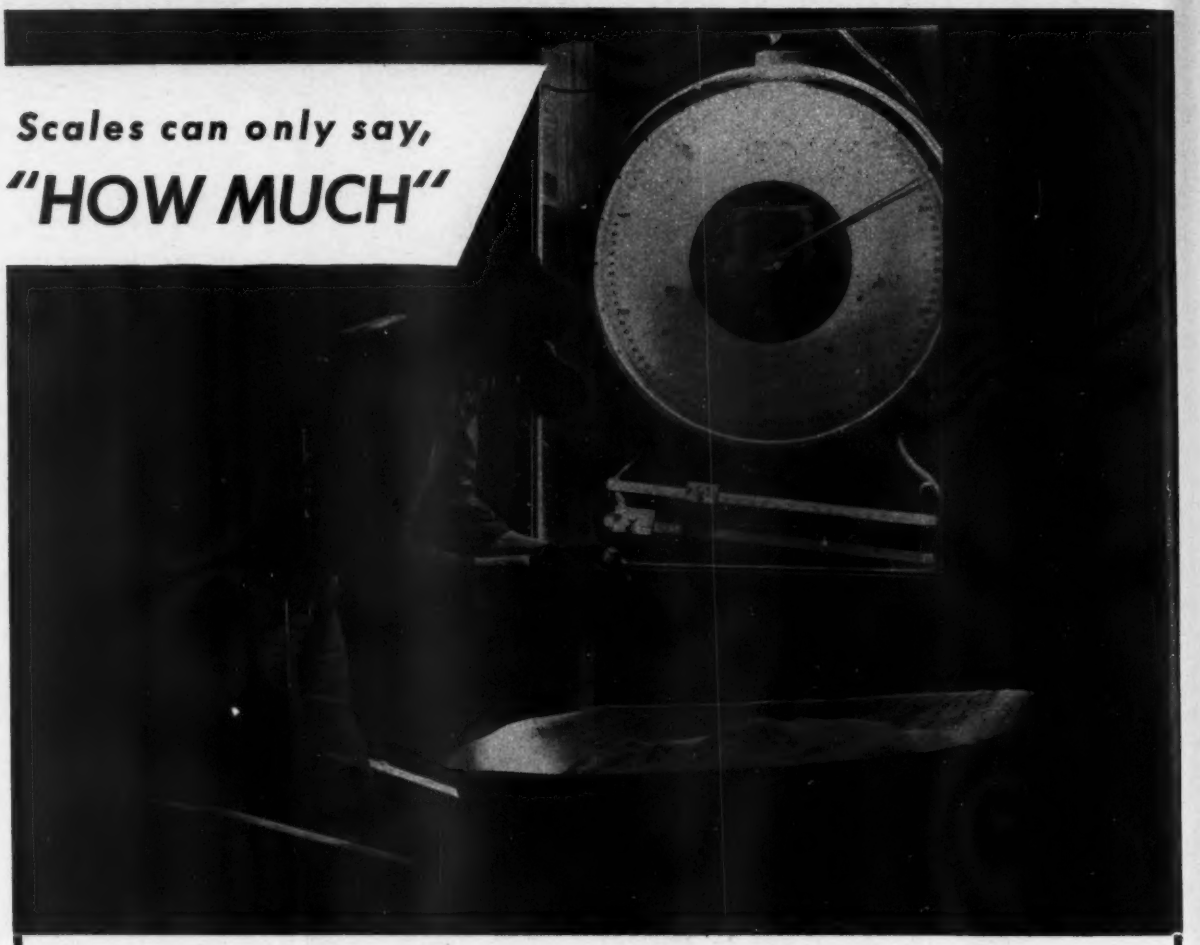
Mathieson

Dense Soda Ash

THE MATHIESON ALKALI WORKS (INC.) 60 E. 42ND ST., NEW YORK, N. Y.

SODA ASH . . . CAUSTIC SODA . . . BICARBONATE OF SODA . . . BLEACHING POWDER . . . HTH PRODUCTS . . . AMMONIA, ANHYDROUS and AQUA LIQUID CHLORINE . . . FUSED ALKALI PRODUCTS . . . SYNTHETIC SALT CAKE . . . DRY ICE . . . CARBONIC GAS . . . SODIUM CHLORITE PRODUCTS

Scales can only say,
"HOW MUCH"



THE finest of scales can only say, "how much" of any ingredient goes into the batch. Making sure they are exactly right for the job must be done long before ingredients reach the scales.

Users of Columbia Dense Soda Ash know from experience that this important material is right for the job. Right purity. Right in uniformity of particle size. Behind every shipment is our rich background of specialization on Soda Ash to meet the precise needs of the Glass Industry. If you are not now using Columbia Dense Soda Ash, it will pay you to learn its fine working qualities at first hand.

• • •

COLUMBIA DENSE SODA ASH

is available in three granulations — in bulk, barrels, paper and burlap bags.

If it's a Columbia Product — You're Sure of the Best

COLUMBIA

COLUMBIA CHEMICAL

PITTSBURGH PLATE GLASS COMPANY

Columbia Chemical Division

30 ROCKEFELLER PLAZA

NEW YORK, N.Y.

Chicago • Boston • St. Louis • Pittsburgh • Cincinnati • Cleveland • Minneapolis • Philadelphia • Charlotte

NEW YORK SOCIETY OF CERAMIC ARTS

The 41st annual exhibition of the New York Society of Ceramic Arts went on view October 27 at the Barbizon-Plaza Art Galleries in the Barbizon-Plaza Hotel, New York City. The show, which is scheduled to run through November 20th, will again cover a wide scope, reflecting the society's decision in 1938 to embrace all ceramic activities rather than confine attention almost solely to pottery, as had been done for many years.

In addition to the usual extensive showing of pottery, the exhibit includes terra cotta and sculpture, tiles, glass, stained glass, enameled metals and other types of ceramic art. An innovation and special feature at this year's exhibition is a collection of ceramics for garden and terrace.

JOHN B. FORD

John B. Ford, retired president of the Michigan Alkali Company, died October 8 at Detroit, Mich., at the age of 75. The deceased was a grandson of John Baptiste Ford, founder of the Pittsburgh Plate Glass Company and considered the original manufacturer of plate glass in this country.

He was one of the prominent industrialists of Michigan for, in addition to his connection with the Michigan Alkali Company, he was also president of the J. B. Ford Company, Huron Portland Cement Co., Wyandotte Transportation Co., Wyandotte Terminal Railroad, Ford Collieries Co. and the Huron Transportation Co. In addition, he was a director of Park, Davis and Company, and the Libbey-Owens-Ford Glass Company.

FILLING EXPORT ORDERS

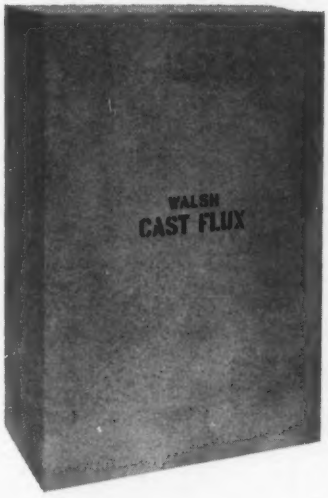
The Bureau of Foreign and Domestic Commerce, Department of Commerce, has undertaken a definite activity aimed at facilitating the filling of export orders to friendly countries. With increasing difficulty of procurement of export goods, on the theory that in many cases shortages are local and not general, the Bureau aims to assist in getting the required goods in areas where they are obtainable. To this end, the Bureau has asked each of its field offices to canvass the situation regularly, to ascertain what, if any, export orders are unfilled because of inability to obtain goods. If a field office is unable to locate a supplier within the region of district, the case will be forwarded to Washington for the immediate attention of the Bureau's Export-Import Market Information Unit.

In view of the spread of the Bureau's offices and their familiarity with sources of export supply it is believed this service will be valuable both to foreign customers and manfacturers and exporters here.

FTC HEARING AGAIN POSTPONED

The Federal Trade Commission hearings on the Elasti-Glass case, originally scheduled for October 29 in Washington, D. C., have been postponed because of the death of Judge William C. Reeves, trial examiner of the Federal Trade Commission, on October 26. The hearings have been postponed since June at the request of respondents, S. Buchsbaum & Co., Chicago, Ill. When completed, the matter will be presented to the FTC for disposition.

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

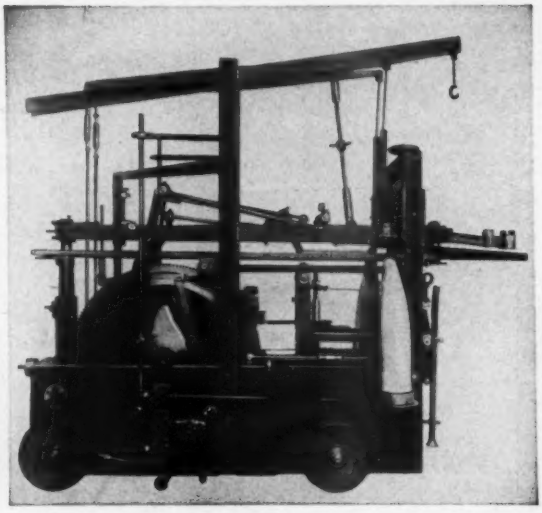
Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street
St. Louis Missouri

ROIRANT

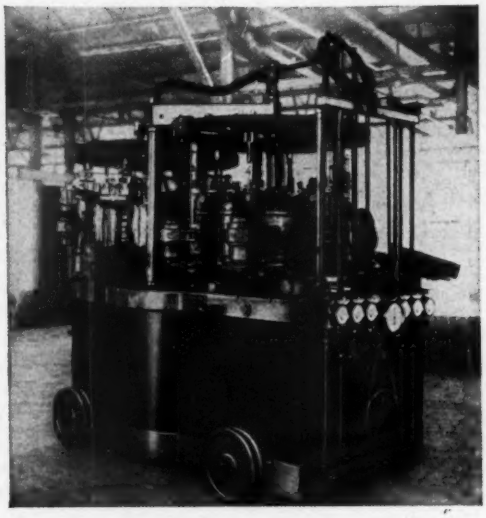
SINGLE AND MULTI-MOULD MACHINES

Universally known for the production of small and large bottles



Type "F" single - mould suction machine for the production of small ware

Type "A6" twin table six-arm suction machine for the production of bottles



Also type "B" single-mould suction machine for bottles and type "BB2" suction machine for carboys up to a capacity of about 14 gallons

Any particulars from:

SOCIÉTÉ CONTINENTALE
D'APPAREILS MÉCANIQUES POUR LA VERRERIE S. A.
7, rue Chaillet, Fribourg, Switzerland

IN THE MAIL BAG

Editor, THE GLASS INDUSTRY:

The comprehensive article "Fear Propaganda Campaign Threatens Glass Tumbler Industry," in the October issue of THE GLASS INDUSTRY, we found extremely interesting. It may interest your readers that a novel solution of the problem of permanent sterilization of glass, enamels, and glazes has been recently found. The K. and R. Chemico-Physical Corporation has acquired the relative patent rights from I. and W. Kreidl. According to their work, bactericidal agents are directly incorporated into the glass, enamel, or glaze. Ceramic wares manufactured in accordance with this invention are capable of sterilizing liquids within a short time, while the liquids remain entirely unaffected. No basic change in the usual methods of the production of the ware is required. The effect is permanent throughout the life of the ware which will continue to give off the bactericidal agents; consequently no further treatments after the initial treatment will be necessary. Data illustrating the bacteriological action of ware prepared according to this process will be reported in a later issue of THE GLASS INDUSTRY.

K. and R. Chemico-Physical Corp.
155 Waverly Place
New York City.

Editor, THE GLASS INDUSTRY:

The article entitled "Water-Glass" by Dr. Bruno Schweig, appearing in your October issue, smacks strongly of European practice, and I am sure that other silicate of soda manufacturers in this country will, like myself, be shocked at the intimation that American silicate of soda glasses vary in color from a light yellow to brown and may carry 2 per cent impurities. It will also be surprising to them to read that 90 per cent of the water glass used is sold as a 36° to 38° Baume solution which sometimes contains "some sodium sulphide or potassium sulphide imparting a nasty smell to the solutions".

Actually American made solid water glasses seldom contain more than one per cent impurities, are clear bluish-green in color, while the solutions most commonly used fall within the limits of 40° to 43° Baume. Most commercial liquid silicates are controlled to a gravity of ± 0.5° Baume or better, and are completely free of any objectionable color or odor. The explanation is to be found in the fact that American producers invariably use soda ash as a source of alkali, and manufacture to much more exacting standards than has been common on the Continent. I do not know of any American manufacturer who deliberately confuses the buyer by changing the ratio of silica to Na_2O from summer to winter.

The section on analysis sets forth methods which are less exact in several respects than those commonly used in this country.

Dr. Schweig's familiarity with the literature of the crystalline silicates is not up to date. It is now known that four crystalline hydrates of sodium metasilicate exist, namely the 9, 8, 6 and 5-hydrates, with melting points of 47.85°, 48.35° 62.85° and 72.20°C, respectively. The 4-hydrate as reported in the earlier German literature is now not believed to exist. See *Journal of Physical Chemistry*, Vol. 42, pages 165-169, February 1938.

Would it not be well to make it plain to your readers when presenting the second portion of this paper that Dr. Schweig writes from European experience and presumably of European practice rather than American practice?

Philadelphia Quartz Company
Chester L. Baker
Chemical Director

DEFINITION OF GLASS

In view of the tentative definition of glass proposed by a Sub-Committee of Committee C-14 A.S.T.M. and already published in this Journal, it might be of interest to our readers to note the following definition proposed by Professor W. E. S. Turner of Sheffield. Professor Turner has followed the American definition very closely in its essential language, although his classification differs materially and goes into much more detail in materials of composition and coloring agents.

"Glass is an inorganic product of fusion which has cooled to a rigid condition without crystallizing. Most glasses are clear and transparent but some contain non-glassy material, always embedded in a glassy matrix. Glasses may be colored by suitable material in either a dissolved or in a dispersed condition."

"Glasses may be classified as:

A. Colorless Glasses.

1. One-component glasses, consisting of single oxides, such as silica, (SiO_2), boric oxide, (B_2O_3), or Phosphoric oxide, (P_2O_5), of which the only important commercial representative is silica glass (fused quartz).
2. Two-component glasses, of which the chief commercial representatives are the soluble silicates.
3. Multi-component glasses, in which, either commercially or experimentally, many of the oxides of the non-metallic elements have been employed, including Na_2O, K_2O, Li_2O, Rb_2O, Cs_2O, CaO, SrO, BaO, PbO, MgO, ZnO, BeO; Ti_2O_3, La_2O_3; ZrO_2; Al_2O_3; TiO_2, Sb_2O_3, As_2O_3, As_2O_5, P_2O_5, B_2O_3, SiO_2.

B. Colored Glasses.

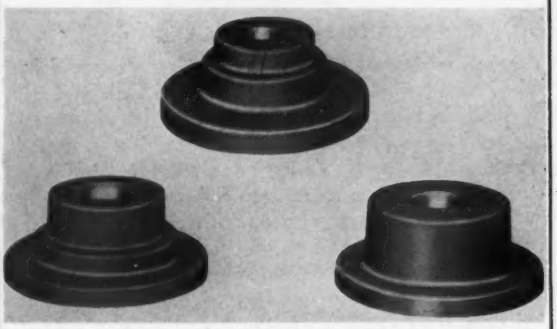
That is, any glasses composed as in I or III, but with the addition of one or more of the coloring oxides or elements of which the following are commonly used: Fe_2O_3, FeO, Cr_2O_3, Mn_2O_3, Ce_2O_3, Nd_2O_3, Di_2O_3, CoO, NiO, CuO, Cu_2O, S, Se, C, Ag, Cu, Au.

C. Opalescent, Opal or Opaque Glasses.

That is, glasses based on a selection of the components as in I or II, but containing dispersing material consisting either of gas bubbles or of solid material, which either separates when the glass is cooled from high temperature or is originally insoluble, such as fluorides, phosphates, arsenates, SiO_2, SnO_2, ZrO_2; or glasses the surface only of which has been obscured by mechanical or chemical treatment.

The above definition by composition covers all descriptive terms in traditional or commercial use such as crown, flint, crystal, demi-crystal; those used in describing the purest and most homogeneous of glasses, namely, those for optical purposes, with nomenclature based on the terms crown and flint; and those based on the main purpose for which glass is used, such as heat-resisting glass. Glasses can only strictly be defined in terms of their composition, their subsequent heat, mechanical or chemical treatment, and resulting physical properties."

Gunite's Standard grade A
for
Guide Rings



Like all Gunite glasshouse castings Standard grade A is used for guide rings because it is best adapted to this particular purpose.

There is a suitable Gunite Alloy for every type of glass mould part requirement. Miller plungers and guide rings, neck ring sticks, brushing stock, press and blow moulds.

Write us for details

GUNITE
FOUNDRIES CORPORATION
ROCKFORD ILLINOIS

THIS CARD

INTRODUCES A FELT EXPERT

The man who sends in an American Felt Company card is worth seeing. He is not a "casual" caller. He will have new, late facts from the field or from the laboratory to pass on to you for the betterment of your product or the curtailment of costs. He will give you bedrock information on time or labor-saving possibilities through the use of FELT. American Felt Company representatives are salesmen . . . good salesmen . . . their aim is to counsel with you as to the *precise* FELT you need for each specific job. When you are using the *proper* FELTS you are a satisfied FELT user. They will then take their chances of selling you *American Felts.*

American Felt Company
TRADE MARK

General Offices: GLENVILLE, CONN.
Plants at Glenville, Conn., Newburgh, N. Y., Franklin, Mass., City Mills, Mass., Detroit, Mich.
Manufacturers of **Polishing Felt, Scratch Wheel Felt, Polishing Wheels, Glass Setting Strips, Blocking Felt, Channel Felt, Table Cover Felt.**

R.C.A.'S REFLECTION-PROOF PROCESS

The Radio Corporation of America has announced a new chemical process to reduce extraneous reflection from glass surfaces and panels. The formula was developed by Dr. F. H. Nicoll, of the R.C.A. laboratories. The process is based upon the exposure of the glass to a hydrofluoric acid vapor, which etches away a small amount of surface, leaving a thin, transparent film of calcium fluoride measuring in thickness approximately one-quarter wavelength of light. It is said that the film can be washed with water, alcohol and many other solutions and subjected to relatively high temperatures without impairment.

GLASS OMITTED FROM TRADE PACT

In the recently signed Argentine Trade Agreement, signed between the United States and Argentina on October 14 in Buenos Aires, glassware was not included in the list of articles upon which tariff was reduced.

The American Glassware Association prepared a statement for the American glassware manufacturers opposing tariff reductions under Paragraphs 218f and 218g of the proposed treaty except as glassware items that could be identified as Argentine specialties. Mr. C. W Carlson of the United States Glass Company appeared before the Committee on Reciprocity Trade Information (THE GLASS INDUSTRY, July, 1941) and at that hearing emphasized the argument that to reduce the tariff on glassware coming in under these paragraphs would develop a new industry at the sacrifice of American manufacturers who were compelled by American standards of living to pay higher wages.

EXPOSITION OF CHEMICAL INDUSTRIES

The Eighteenth Exposition of Chemical Industries will be held at the Grand Central Palace, New York City, Monday, December 1 to Saturday, December 6. More than 300 exhibitors have enrolled for the Exposition and contracted for an aggregate of space on three floors of the Grand Central Palace amounting to more than three acres. Among them are numbers of the industrial chemical companies, several of the larger general manufacturing units, and many highly specialized concerns. Many of the concerns are specialists in both materials and equipment. Specialization in high degree is also the qualification of many exhibitors of smaller magnitude, but of greater importance because their products are unique, or because of extraordinary capacities for invention, accuracy in manufacture, close process control or pioneering in new fields.

Admission will be by invitation and registration at Grand Central Palace. The Exposition will not be open to the public at any time.

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THE TOLEDO TRIAL

(*Continued from page* 475)

neers in the glass world, told a dramatic story of the introduction of automatic equipment in the glass factories. Because of the background of his story ante-dated the specific allegations of the Government, the U. S. attorneys objected strenuously, only to be overruled by Judge Kloeb, who said it will be his policy to be liberal in this respect.

Government attorneys, obviously anticipating such a situation, appeared with briefs already prepared in support of their objections. Debate on the effort to cripple the defense by limiting its testimony occupied an hour and a half of the first day of Mr. Peiler's testimony.

Mr. Peiler said the patent licensing policy, upon which the Hartford-Empire Co. is founded, was the consummation of an early decision by the firm. He explained how inventors in those days worked without compensation, spending their lifetimes and their resources in an effort to improve the industry.

The licensing policy, Mr. Peiler said, was based on a plan to return one-third of the net benefit of an invention to the consumers, one-third to the investors, and one-third to the inventor. Licensing fees were worked out on this formula, he testified.

It was expected Mr. Peiler would occupy the witness stand for several days.

THE URBANA CONFERENCE

The Seventh Conference of Glass Problems will be held at the Department of Ceramic Engineering, University of Illinois, Urbana, Ill., on Friday and Saturday, November 14 and 15.

A partial list of the papers to be presented is as follows:

"A Progress Report on the Research on Molds for Glass," which has been conducted by Professor Bruckner, Department of Metallurgy, University of Illinois.

"An Analysis of Strains in Glass Produced by Applied Ceramic Colors," by J. E. Ablard, B. F. Drakenfeld & Co., Washington, Pa.

"The Elimination of Destructive Batch Dust in Continuous Tank Furnaces," by C. F. Frazier, Frazier-Simplex, Inc., Washington, Pa.

A paper by Dr. S. R. Scholes, Dept. of Glass Technology, New York State College of Ceramics, Alfred, N. Y.

"Some Recent Work on Cords in Glass," by W. B. Silverman, Owens-Illinois Glass Co., Toledo, O.

"Sources of Stones in Glass," by D. W. Ross, Kirkwood, Mo.

"Research on Glass in the Laboratories of the Department of Ceramic Engineering, University of Illinois," by C. W. Parmelee and A. E. Badger.

Programs of the Glass Conference may be had by applying to C. W. Parmelee, Head, Department of Ceramic Engineering, University of Illinois, Urbana, Ill.

Hotel reservations should be made in advance at one of the following: Urbana-Lincoln Hotel, Urbana, Ill.; Plaza Hotel, Urbana, Ill.; Inman Hotel, Champaign, Ill.; Hotel Tilden-Hall, Champaign, Ill.; and the Hamilton Hotel, Champaign, Ill.

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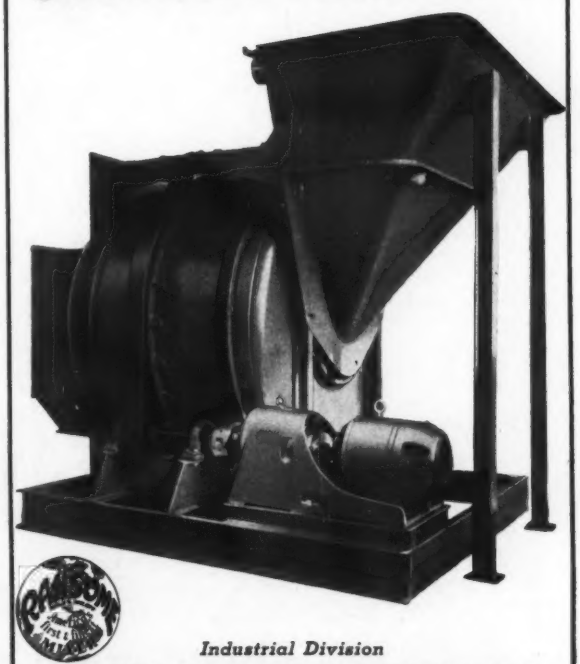

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF MARCH 3, 1933.

THE GLASS INDUSTRY, published monthly at 11 West 42nd Street, New York, N. Y., for October 1, 1941, State of New York, County of New York, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John T. Ogden, who, having been duly sworn according to law, deposes and says that he is the Publisher of THE GLASS INDUSTRY and that the following is to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: John T. Ogden, 11 West 42nd Street, New York, N. Y.

2. That the owners are: Ogden-Watney Publishers, Inc., 11 West 42nd Street, New York, N. Y.; John T. Ogden, 11 West 42nd Street, New York, N. Y.; Katherine Waller Ogden, 11 West 42nd Street, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed)

JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 30th day of September, 1941.

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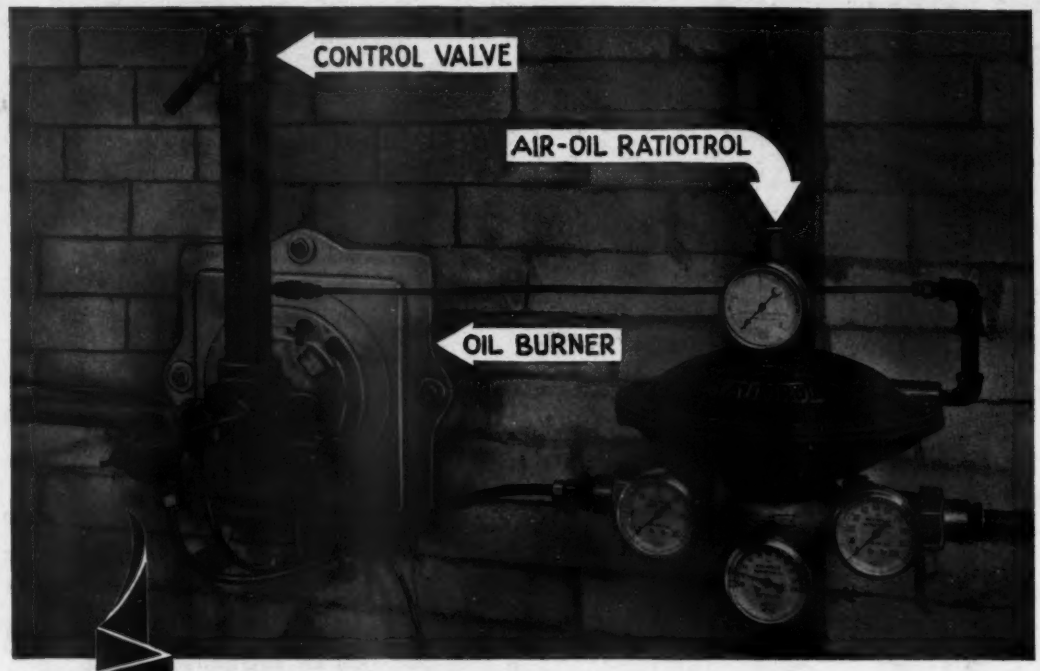

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